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Popular Science

The What's New magazine

DAMADIAN'S SUPERMAGNET

How he hopes to use it to detect cancer

Ram-wing X-114

floats, skims, and flies

How 914-MPG CAR won super-mileage contest

Big sound from those new MINI-SPEAKERS

New DIGITAL WATCHES do more than keep time

SOLAR PONDS: heat from a hole in the ground

PS guide to FIRE EXTINGUISHERS

Your car: a pro tells you how to make BODY REPAIRS

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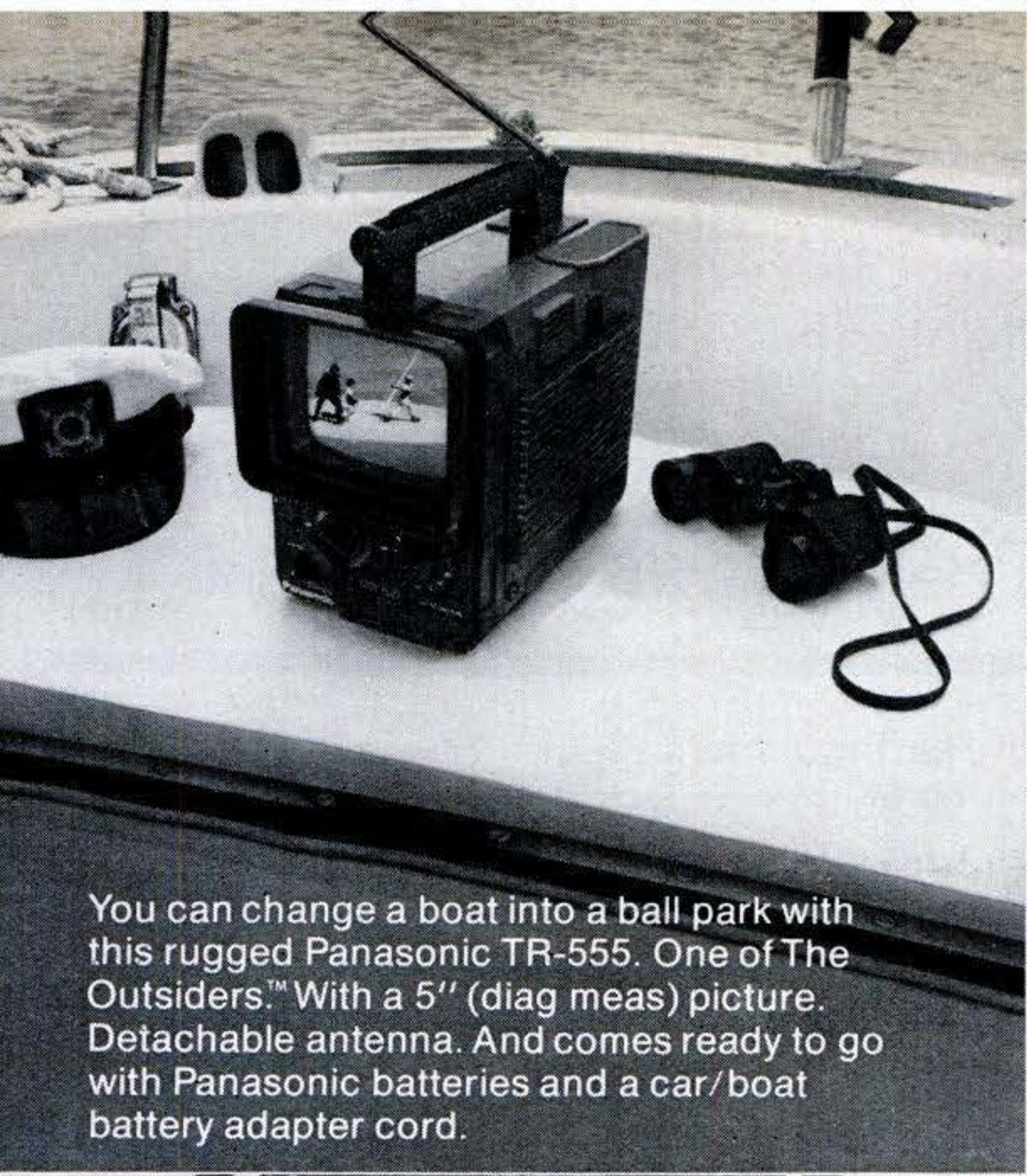

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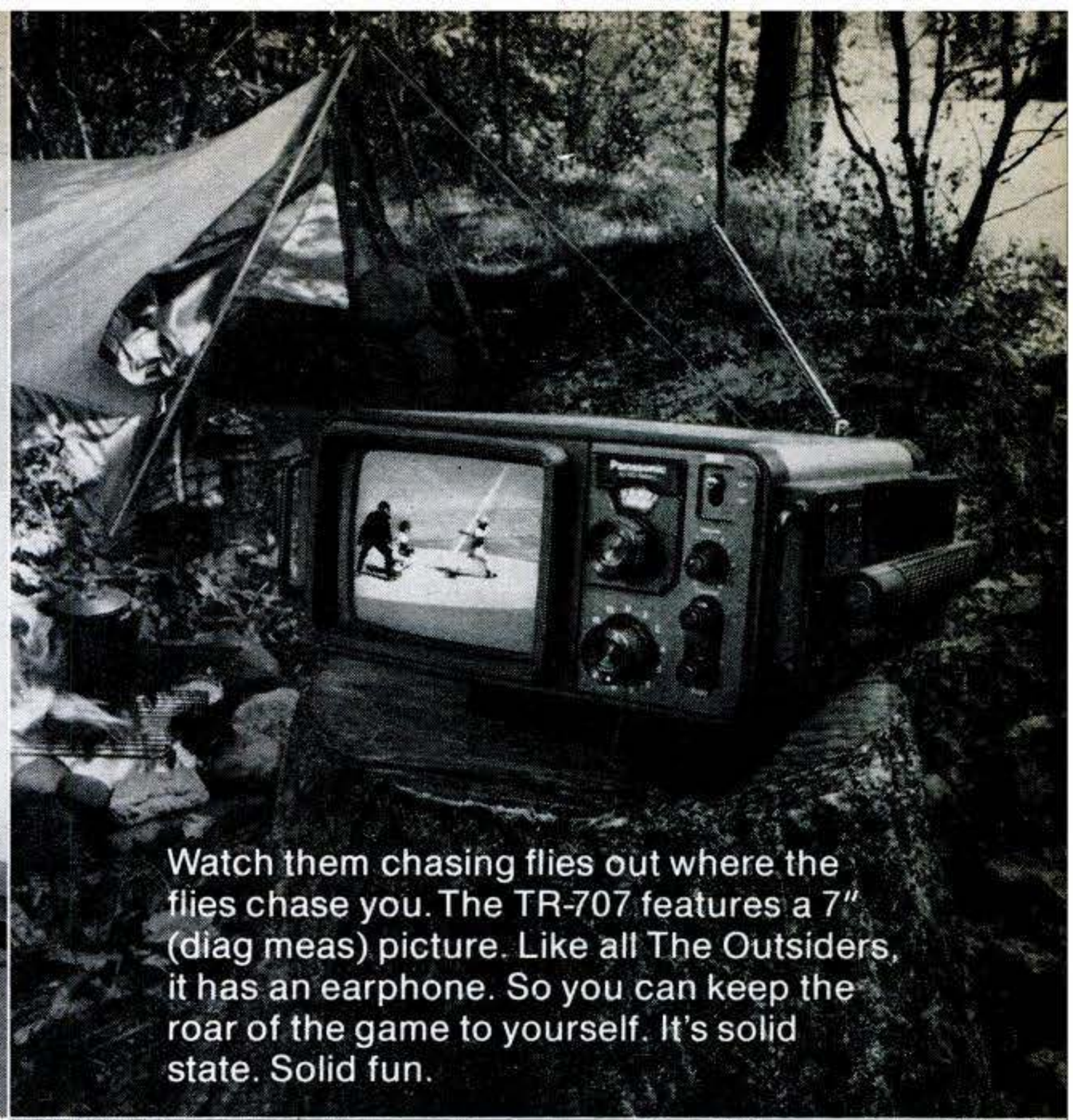

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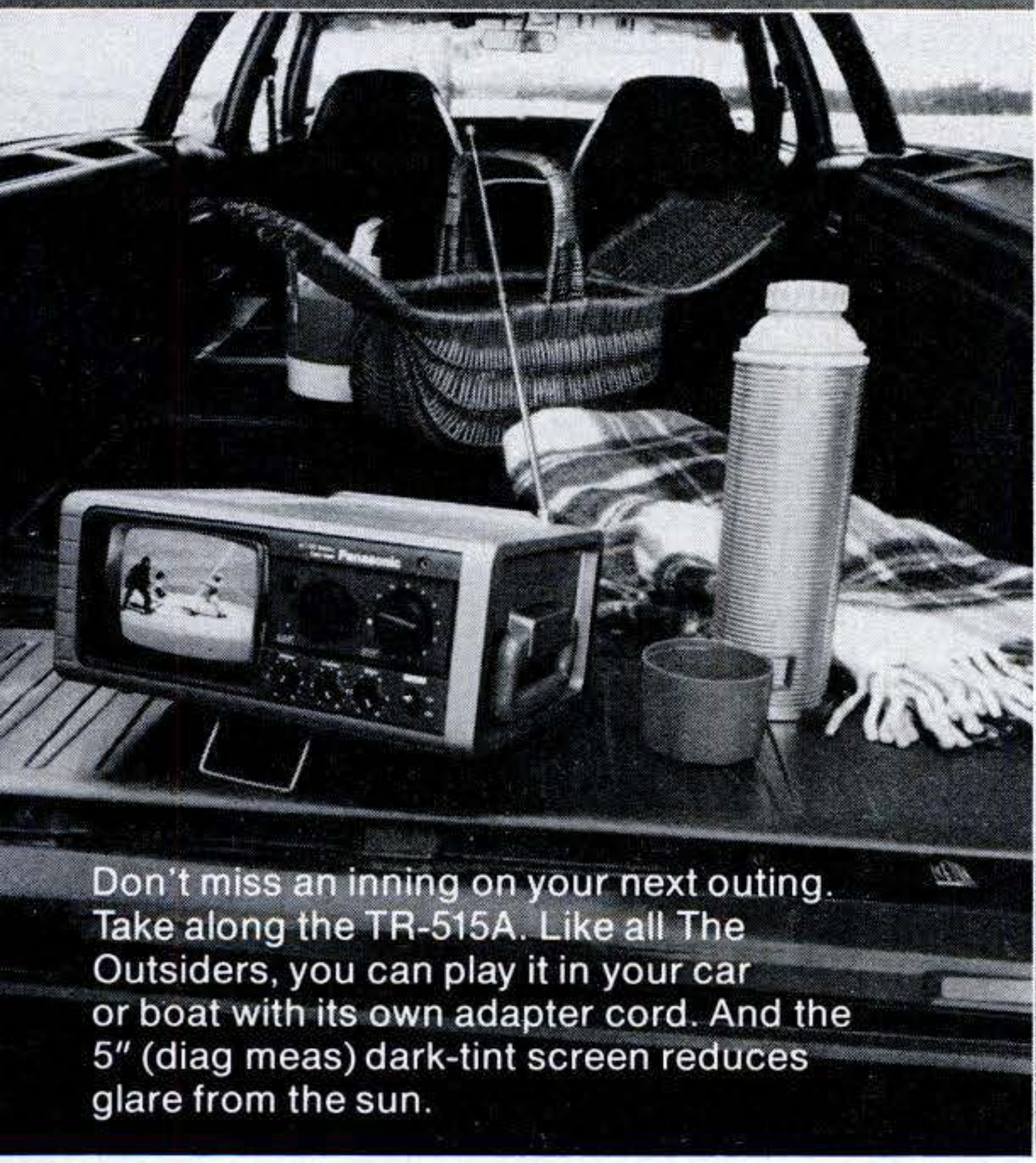

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The What's New magazine

HIGHLIGHTS OF THIS ISSUE

PS guide to fire extinguishers
Identify your fire hazards, then choose the right extinguisher from our guide. PAGE 58

Ram-wing X-114 floats, skims, and flies
This fascinating craft flies best in dense air near the surface, saving fuel. PAGE 70

Damadian's supermagnet
A physician uses electronic techniques in effort to detect cancer. PAGE 76

914-mpg car wins super-mileage contest
Air drag proves more critical than weight, even when slow is beautiful. PAGE 100

Sun power makes window greenhouse self-ventilating
You can build better than you can buy, using these step-by-step details. PAGE 108

CARS AND DRIVING

PS car test: subcompact sports coupes—economy with verve . . . 26
914-mpg car wins super-mileage contest 100
A pro tells you how to make body repairs 104

ENERGY NEWS

Energy adventure: tubular collector in drain-down system . . 52
Solar ponds—heat from a hole in the ground 80

NEW PRODUCTS AND INVENTIONS

Swing-beam crank system quiets opposed-piston diesel 74
Wood I-beams save energy, save lumber, save money 92
Today's digitals—precise timekeeping and much more 102
Garbage grabber collects trash fast 139

SPACE AND AVIATION

Ram-wing X-114 floats, skims, and flies 70
Offbeat new planes from the Paris Air Show 94

HOME AND YARD

PS guide to fire extinguishers . . . 58
PS leisure home: sun cottage for all seasons 93
Sun power makes window greenhouse self-ventilating 108
Chisels and gouges that work where power tools won't 111
Install your own water softener . . 114
Measure your fireplace for top performance 118
Upgrade thermal efficiency: Plug leaks in heat-wasting doors 128
Fuel shed stores flammables at a safe distance 138
The facts (and myths) about snowthrower safety 142

WhatsNew DIGEST

First U.S.-made FWD minicar . . . 82
Easy-access F-15 83
Computer guide for tourists 84
What's new in boating 85
What's new in tools 86
What's new in home improvement 87
What's new in electronics 88
What's new in cars 89

SPECIAL REPORT

Damadian's supermagnet: how he hopes to use it to detect cancer . . 76

ELECTRONICS

Field tests reveal strange facts on locating your car's CB antenna 90
Big sound from those new mini-speakers 98

OUTDOOR RECREATION

PS test report: Mercury's 200-hp outboard 8

REGULAR FEATURES

PS readers talk back 4
Science newsfront 16
Boating beat 22
Through the viewfinder 38
New ideas from the inventors . . . 44
"Say, Smokey—" 46
Motorcycling 48
Detroit report 50
Wordless workshop 64
PS/What's news 69
Shop talk 124
Taking care of your car 148
Housepower clinic 150

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PS READERS TALK BACK

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Economical but inconvenient

After reading "Turn Your Fireplace into a Furnace" [Oct.] I felt the need to mention a few of the disadvantages of such a system. I rigged up my fireplace with a grate made out of ¾-inch black pipe, a small rotary pump, a 55-gallon drum for a storage tank, and a large heater core mounted in front of a squirrel-cage blower. My system worked fine and would keep my seven-room Cape-style home comfortably warm down to about 15° F. Anything colder and my conventional furnace would turn on.

However, there are inconveniences to such a system. The first is that the fire needs almost constant attention. The grate takes a lot of heat away and as a result the fire tends to die a lot faster than normal. A second disadvantage, common to most fireplaces, is that if you have a fire in the evening and leave the flue open when you go to bed, most of the heat you save will go up the chimney while you're sleeping. A third disadvantage, which I feel a lot of people don't realize, is the amount of wood it takes to heat a home. It takes more than just a few face cords; and there's a great deal of work in cutting, stacking, and carrying.

If you like to tinker and aren't afraid of a little work, the fireplace heating system can be a real money saver. However, it will never replace the convenience of the modern furnace.

Thomas M. Nesbitt, Hilton, N.Y.

Insulation upgrade

In your "Insulation Upgrade" article [Sept.] the author stated that insulating [crawl space] perimeter walls in cold climates is risky business.

We are located in northern Wisconsin and considered insulating our perimeter walls to protect water pipes under the house from freezing. This is something we couldn't insure if we insulated the floor, since the heat from the living area wouldn't be able to radiate under the floor to keep the pipes warm.

My question is, why is insulating perimeter walls in cold climates risky?

Mark E. Lasee, Sturgeon Bay, Wis.

Al Lees replies: "Insulation experts warn that crawl-space foundations, insulated as we depicted, could buckle from frost heave in areas of extreme ground penetration. I'm surprised that a home builder in northern Wisconsin would expose water lines below *floor joists in an unheated crawl space. But if that's what you're stuck with, your best bet is an electric heat tape for those pipes. (The Frostex cable I described in Feb. '77 Shop Talk is now packaged for DIY'ers.) Then you can insulate the underside of the floor as decribed in my September article."*

Your article "Insulation Upgrade" seems to leave the idea that fiberglass is the only DIY insulation. But I insulated my house last summer with blown-in cellulose fiber, with excellent results, if the way the house stayed cool is any indication. A few of the methods I used are unusual, so they might interest your readers.

The house already had been capped with fiberglass in the attic and the original builder had included a vapor barrier in the walls. The walls were matched boards inside and shiplap outside, nailed directly to the studs. This is common New England construction on small houses.

The insulation I used was US Fiber cellulose, and the blower was rented from the local supplier ($5 a day). The insulation was done from inside through holes within six inches of the ceiling. These were later covered with 1-by-8 boards, which we painted our trim color. No patches show except where the insulation was blown in under the windows. Here, I adapted the blower down to a smaller hose, and used wooden plugs. The small hose was also used to work the insulation into a horizontal area more than eight feet long by snaking the hose into the far end of the area, using a standard-size hole with a cloth around the hose, and withdrawing the hose gradually as the area filled. (Thanks goes to the US Fiber instruction book for

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hiss and hertz

Two reasons to complete your stereo system with the new Realistic SCT-15 Dolby* cassette deck

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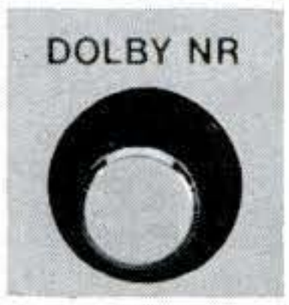

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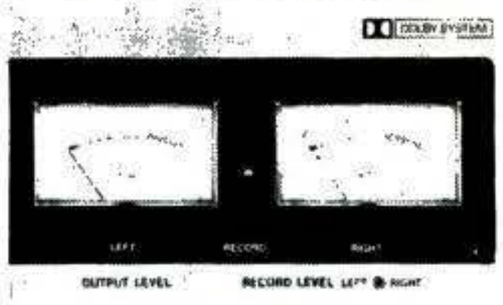

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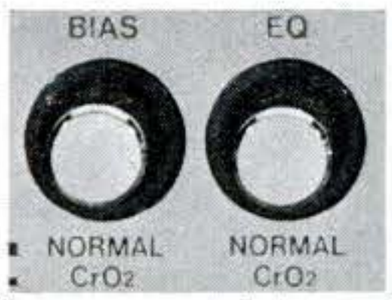

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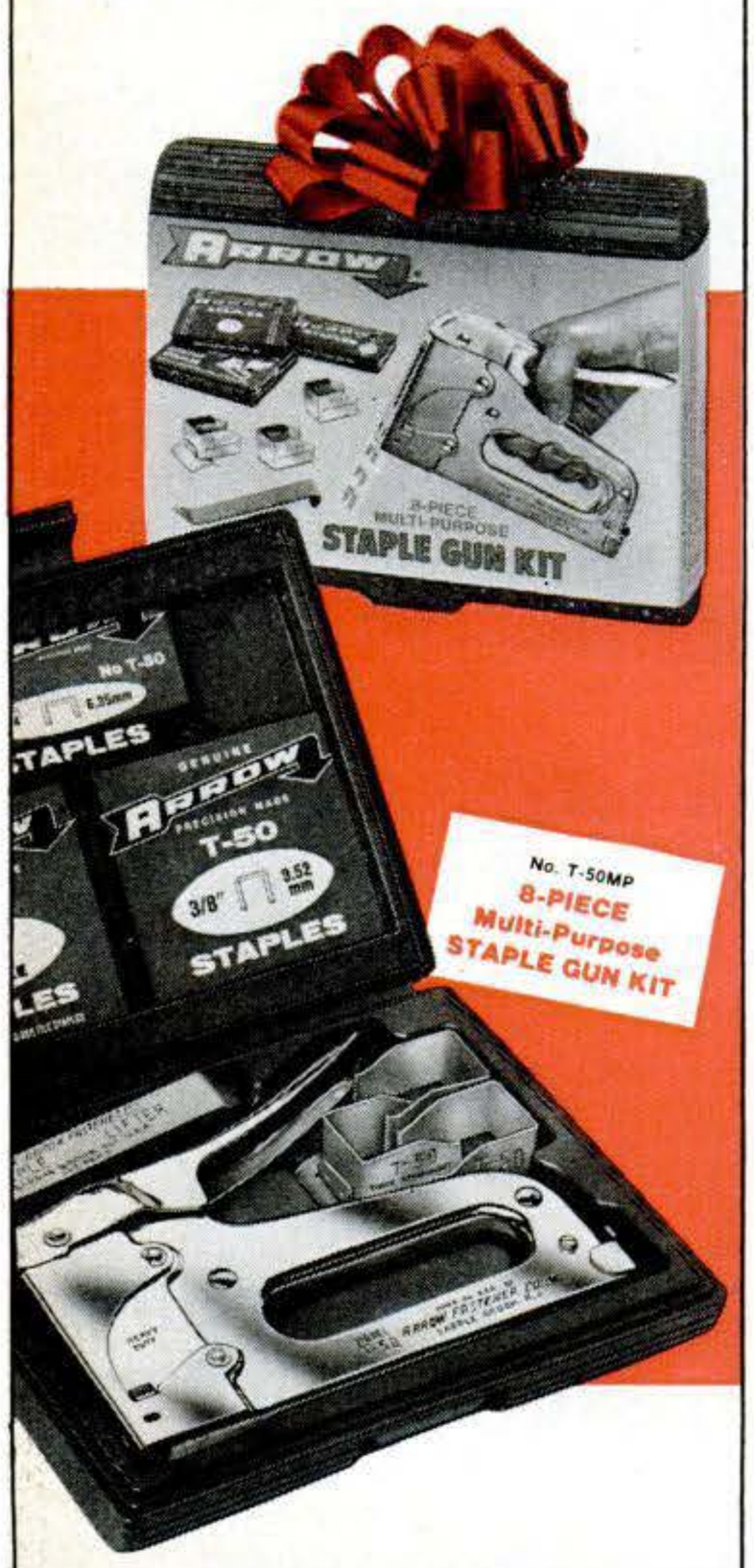

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[*Continued*]

this idea.) You can blow with a one-inch hose—it just takes longer.

One thing to watch for, as the company noted, is the possibility of obstructions in the walls, such as a line of 2-by-4's crosswise at chair-back level. I checked for this with an electrician's snake from above.

During the summer, temperatures inside the house stayed 10 degrees or more below outdoor temperature, as long as I kept things closed up. I am very interested in the effect on my fuel bills this winter.

Joel S. Look, Claremont, N.H.

To insulate hollow walls of existing houses, blown-in fiber is the only DIY option—and if you do as thorough a job as the above description suggests, results will be quite effective. And with the shortage of fiberglass we warned about in our September article, cellulose may well be the most available material. Be certain it is properly fireproofed, however.

Heat-leaking foundations

In the September feature on Shelter Institute homes, on page 116, the statement is made that concrete emits as much heat as windows. If the author is trying to say that the foundations of ordinary homes lose as much heat as a similar area of window glass, he is dead wrong. Having performed more thermographic studies on houses and buildings than possibly any one other person in the States, I have seen the anomaly that he refers to many times and it is not as stated.

I have seen heat-leaking fieldstone foundations where the mortar has "died" and fallen out. Once in a while I have seen poured-concrete foundations that have settled and cracked, and heat pours out through the crack. But in a typical poured foundation, the heat transfer through the concrete is insignificant.

The flaw in the typical construction lies in the common practice of laying the sill on the foundation with loose sill bolts, shimming the sill level with slivers of cedar shingle every few feet, then splatting mortar against the sill and foundation all around the house—just enough to keep light from shining through. In due time, the mortar falls off and leaves a gap. I have measured gaps as great as 1.5 inches. An amateur thermographer then sees a cascade of hot air heating the outer surface of the otherwise excellent poured foundation. I usually recommend cramming in some good caulking—not insulation—for strength, vermin-proofing, and stopping the draft.

And incidentally, as for building on telephone-pole pilings, using brand-new, pressure-treated poles in a damp climate or in reaching below the water table, I'd give the house 10 to 15 years before it tipped over.

Paul E. Vogel, Marshfield, Mass.

Sweet concrete

In Shop Talk [Aug.], you suggested the use of sugar to delay the setting time of concrete. Your concrete expert Richard Day claimed that sugar would also increase the strength of the concrete.

If it is indeed true that sugar increases the strength of concrete, there are a lot of World War II resistance fighters with red faces. They thought they were sabotaging Hitler's West Wall by putting sugar in the Germans' concrete. Sugar was supposed to weaken the concrete, so that when a shell hit a pillbox the concrete would crumble like sandstone.

I quote from Paul Carell's book, *Invasion—They're Coming!:* "A quarter of an ounce of sugar—just three lumps—dropped into the water of a concrete mixer, was enough to rob two hundredweights of concrete of its strength, for if calcium combines with sugar, instead of carbon dioxide, a readily soluble calcium saccharate is formed."

You might have Mr. Day recheck his facts just to be on the safe side.

Allan W. Failkirk, Keokuk, Ia.

Richard Day replies: "Join the club of PS readers who raised this point. A good many also called for giving me 30 lashes with a serrated sugar cane. Truth is, you can use a tiny amount of sugar in concrete as an emergency retarding agent and not destroy the strength of the hardened project. While scientists who devote their lives to the study of cement and concrete don't fully understand what happens when sugar is mixed into concrete, they do know the results. At extremely low concentrations, such as the one-twentieth of one percent by weight sugar that we called for, adding sugar (sucrose) slows concrete's initial hydration reaction, often increasing its ultimate strength.

"This effect is verified by Nathan R. Greening, director, Chemical-Physical Research Dept. of the Portland Cement Assn. Center for Research, in Skokie, Ill. 'Sugar in concrete is funny stuff,' Greening says. 'The actual reaction depends on cement composition.' With many portland cements and no water adjustment, a 0.05-percent sugar concentration, Greening tells me, produces 'usually a little more strength.' But he warns that, beginning at a 0.25-percent concentration of sugar (five times the amount we specified), 'something screwy goes on.' Then sugar may promote the opposite effect—early stiffening and a decrease in ultimate strength over that of a normal mix. And at a still higher one-percent concentration (20 times our figure), Greening says that the concrete mix may quickly set up enough to walk on, but not increase in strength much beyond that for months. So the indiscriminate amounts of sugar (and honey, too, I've heard) tossed into Nazi concrete mixes by saboteurs could well have had a weakening effect. At any rate, it makes an interesting story. I'll drink to it. One lump or three?" PS

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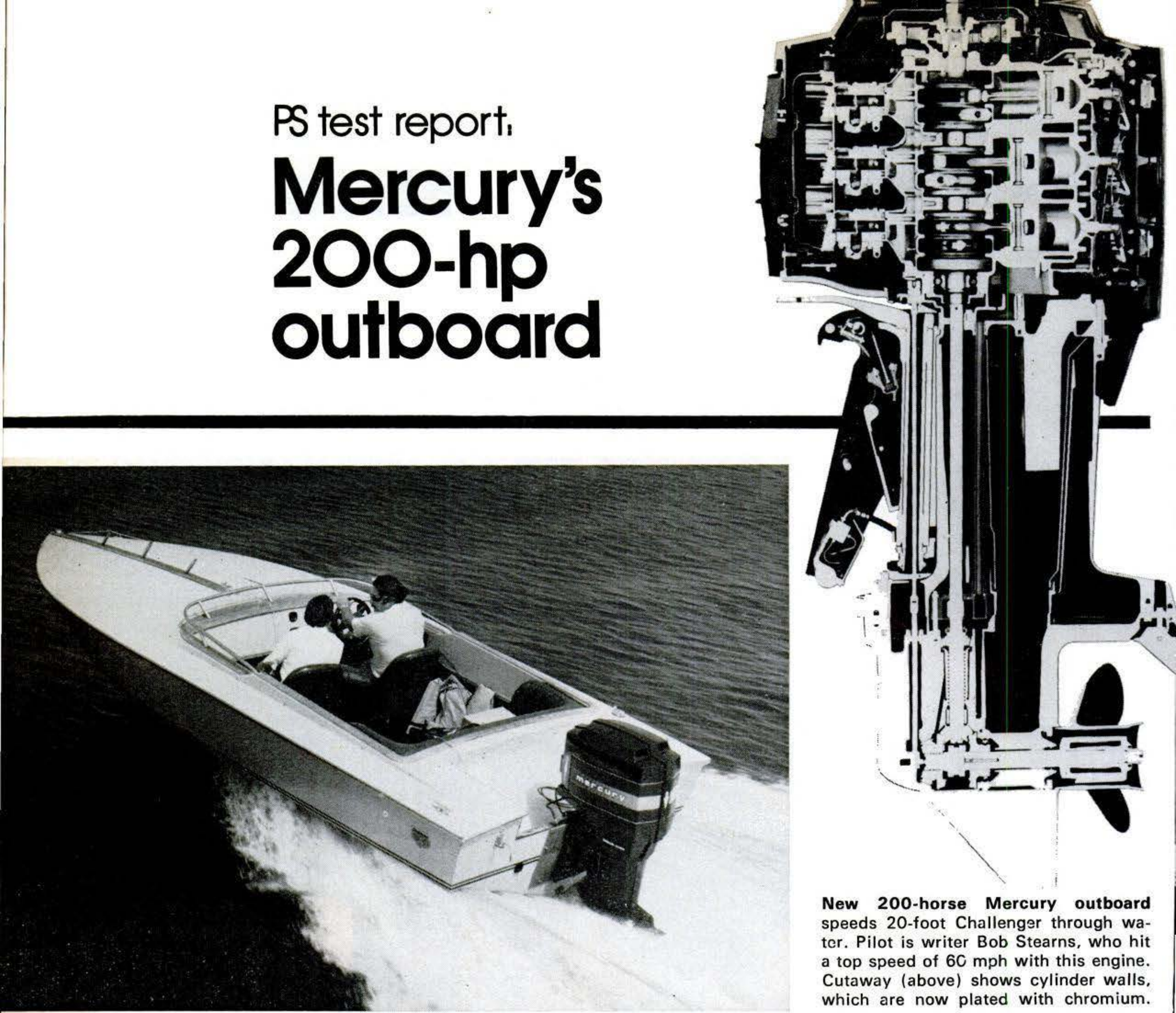

New 200-horse Mercury outboard speeds 20-foot Challenger through water. Pilot is writer Bob Stearns, who hit a top speed of 60 mph with this engine. Cutaway (above) shows cylinder walls, which are now plated with chromium.

More power with less weight—and it's loaded with engineering innovations

By BOB STEARNS

Mercury Marine has a new 200-horsepower outboard for '78—a predictable increase to keep the big Mercs in the same range as the competition.

Last year's Merc 1750 (175 hp) developed its power from 121.9 cu. in. This year's largest Black Max, the Merc 2000, uses 142 cu. in. to develop its rated power.

The 2000 uses the same block that the 1750 did. Merc engineers used a clever trick to get the extra displacement; the iron cylinder sleeves used in the 1750 were eliminated. Instead, in the 2000 the aluminum cylinder walls are plated with chromium, an extremely hard metal that is far more wear-resistant than iron. This is the first time the technique has been attempted with a two-cycle engine of great horsepower.

During my visit to the Mercury test station in Oshkosh, Wis., to try this new engine, I examined the block of a Merc 2000 that had been put through 180 hours of full-throttle operation. The cylinder walls were mirror smooth with no visible scoring. Nor was there evidence of the typical "step" at the top of the cylinder where the top piston ring stops at the end of the stroke.

And there are other advantages to the chromed cylinder walls. Mercury engineer Jerry Hale says this change has increased the heat-transfer rate by 55 percent. The former iron liner is much thicker than the chrome plating, and there is an interface between the iron sleeve and the aluminum block that also acts as a heat barrier. The ability to transfer heat more rapidly should help prolong ring life.

TEST RESULTS

RPM	MPH	GPH	MPG*
1500	8.6	3.18	2.70
2000	11.5	5.62	2.05
2500	21.5	7.03	3.06
3000	28.0	7.76	3.61
3500	33.5	7.83	4.28
4000	41.0	8.91	4.60
4500	47.0	10.59	4.44
5000	52.9	12.16	4.35
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*Miles per gallon in still water. Wind and/or currents could affect these figures significantly.

Additional refinement of the exhaust system through enlarged ports, lengthening of the pathway between ports, and careful tuning of the exhaust system all contribute to both high horsepower and better midrange cruising fuel economy.

The ignition system remains essentially the same as that in the 1977 Black Max: a breakerless

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Thus the Mercedes-Benz Diesel has fully come of age. It stands today at such a peak of refinement that a limited-production Diesel sports Coupe is not sacrilege but logic. Meanwhile, savor your new luxury of choice.

No boulevard sports car

Gasoline- or Diesel-powered, this new Coupe is no faddish "personal" car but a lithe five-passenger machine you will prize as much for its quick reflexes as for its elegant lines.

You sit cradled within a wheelbase of only 106.7 inches, less than a foot longer than the close-coupled 450SL Roadster. You should find yourself negotiating even tight mountain curves with a sense of ample road to spare, slipping through city traffic like a fish. Chances are, within a few days you will stop having to envy sports car drivers forever.

But family men can rest assured. There is not only a full rear seat but a rear seat that nearly equals the 280E Sedan for headroom. And there is not only a full trunk but a trunk with the same 12.6 cubic feet of space as the 280E.

Some people don't understand how Mercedes-Benz builds such space-efficient cars. Mercedes-Benz doesn't understand how to build anything else.

Worth its weight in strength

The new Coupe's taut profile is aerodynamically "clean." Put under an X ray, it would be revealed as the skin over a steel cage welded at 4900 points to a steel platform, forming a monocoque structure.

The engineers braced that sheet-steel floor with cross members to help stiffen the midsection. And although the side windows are pillarless, the concealed "B" pillar provides additional structural integrity.

Straight-line braking stability

Engineers and not stylists are the heroes behind the Coupe. If this 1¾-ton, five-passenger machine seems to corner flatter and grip the road more tenaciously than you're accustomed to, credit them.

They in turn would credit technological nuggets like fully independent suspension, and *zero offset* steering with straight-line stability, *even* in panic stops.

Panic stops are further softened by 4-wheel disc brakes. Mercedes-Benz would never build a Coupe or any other car without them.

But *handling brilliance* is only half the tale. The other half is the ride: Over-the-road decorum worthy of an expensive motor car. *A clue:* The shock absorbers' lower chambers are pumped full of *nitrogen* gas as an extra cushion against vibration.

Power assists a purist can love

No brute force is needed to pilot your Coupe about. Power steering, power brakes, and a 4-speed automatic transmission slightly smoother than the human hand are standard features. Wives will approve. And so will driving purists—because these laborsaving devices have been designed to preserve driving "feel" at all costs.

Not a superficial ounce of chrome

Doors over four feet wide swing open to reveal a meticulously ordered cockpit. Electric windows, bi-level climate control and AM/FM stereo radio are all built in, but the mood is less opulent than crisply businesslike.

For instance, the interior has no dazzling chrome knickknacks to confuse the driver's field of vision. Glare-free gauges are placed so you can check them without breaking visual contact with the road.

The anatomically contoured twin front seats are thickly padded, their springs tuned to the car's suspension. The backrests lock in place *pneumatically.*

And the walnut-root veneer that trims the instrument panel and covers the console is *real* walnut-root veneer.

A delicious dilemma

Which engine version belongs in your Coupe?

Classicists will feel most at home with the 280CE and the familiar traits of its gasoline power plant—supple and responsive in the sporting Coupe manner. And hardly a mundane choice: The 280CE marks the zenith of Mercedes-Benz six-cylinder engine development.

The 300CD allows Coupe devotees to combine their love for elegance with common-sense motoring, and Diesel devotees to combine their love for common-sense motoring with elegance. The power of its 5-cylinder engine is one surprise, the lack of noise and roughness is another. That it offers the established advantages of a Diesel should be no surprise.

But there is ultimately only one way to decide which Coupe best suits your needs. See your Mercedes-Benz dealer and experience them both.

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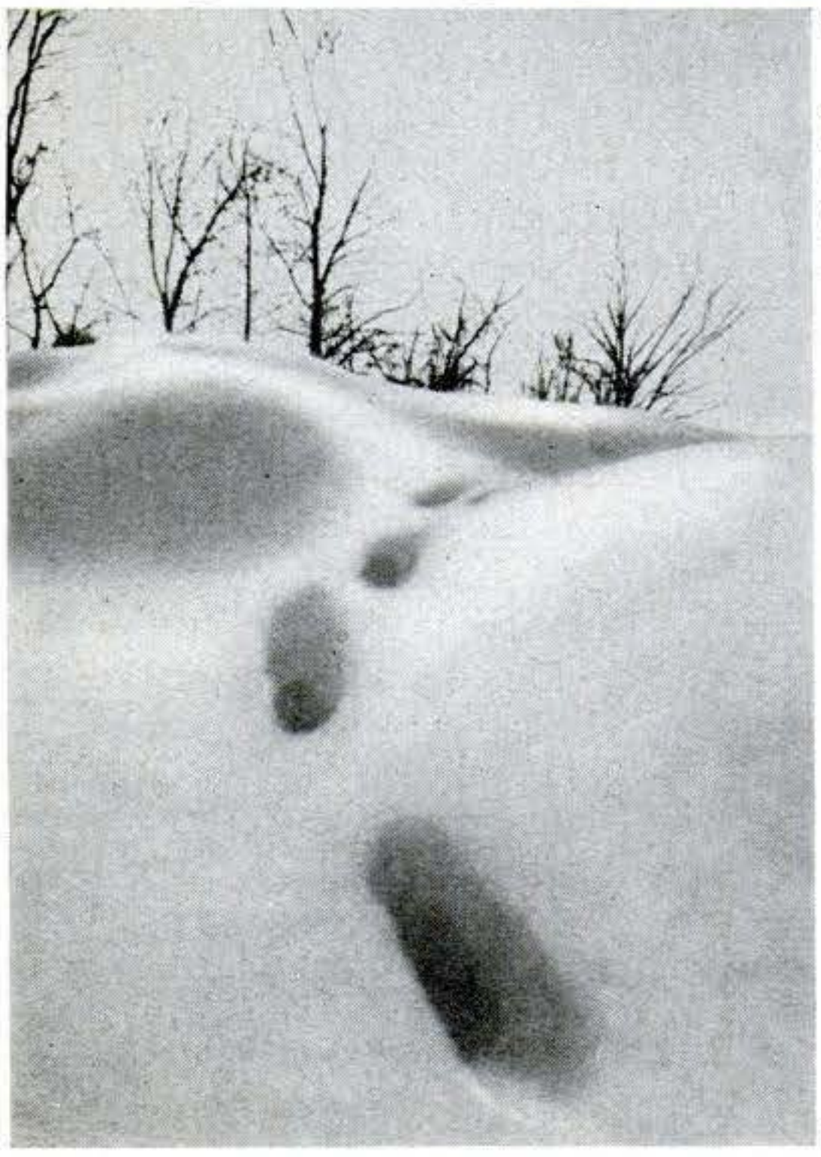

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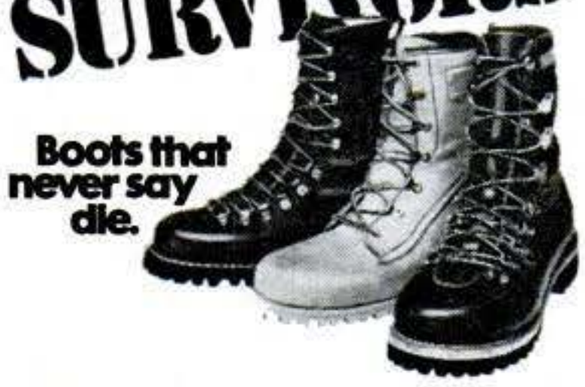

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200-hp outboard

[*Continued*]

capacitive-discharge (CD) system with separate circuits for each bank of cylinders. This includes two separate switching circuits for each cylinder. A total ignition failure is almost impossible—even with one circuit completely out, the engine will continue to run on the other bank of cylinders.

Outwardly, the Merc 2000 is similar to last year's 1750. It's the same size, but, without the iron liners in the cylinders, actually weighs about 19 pounds less (approx. 331 lbs. for the 20-in.-shaft version compared with 350 for the 1750).

But there are significant design changes in the lower unit:

- Reshaping the top of the gearcase has accomplished a breakthrough in spray control, says Merc design engineer Dick Snyder. "We've removed the cavitation plate entirely from the front half of the strut. Now water comes cleanly off horizontally—not upward."
- Moving the center of rudder pressure aft has reduced the tendency for fast, light hulls to chine-walk (sway from side to side). The new position helps the gearcase track straight ahead. And with the bigger hull I drove there was no problem in maintaining stability in tight turns.
- Increasing the distance between the trailing edge of the skeg and strut, and the aft end of the "torpedo," has raised the blowout speed (speed at which exhaust may blow water away from the propeller, resulting in sudden drop in speed as it loses push). The contour of the trailing edge has been changed to make this improvement.

Water-testing the new Merc 2000 revealed some interesting changes from last year's Black Max. The boat I drove was a 20-ft. Challenger, and in several runs over a measured course it was capable of hitting a top speed of 57.9 mph. This was on smooth water. Out on open water, when I was able to trim the engine all the way out with its power trim (standard equipment), I managed to get speedometer readings of a little better than 60 mph. That's pretty respectable for a hull of this size.

Low-end torque was excellent. I could easily get the rig on plane in 2½ seconds. And noise levels were pleasantly low. Conversation in the driver's seat, approximately six feet ahead of the engine, was limited (at full throttle) more by wind noise than by the engine. PS

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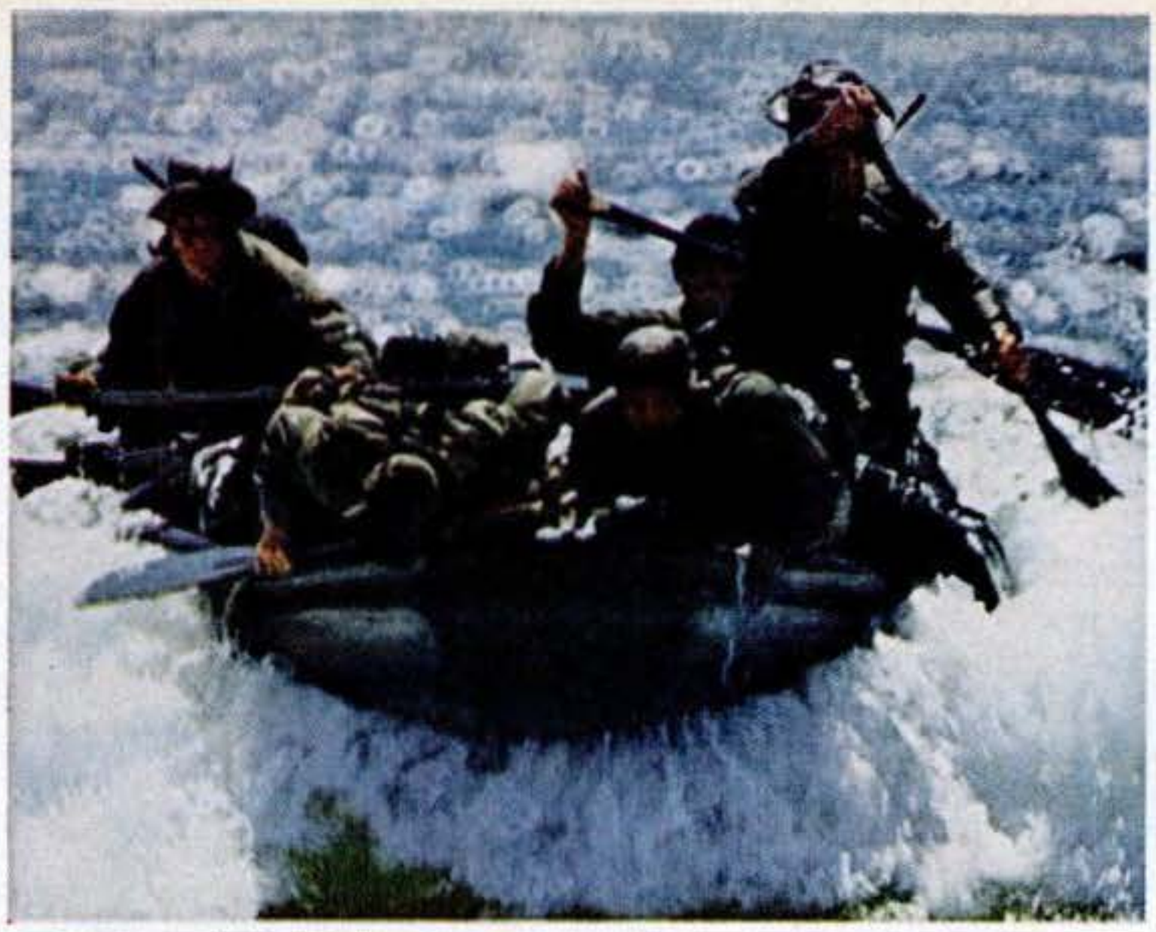

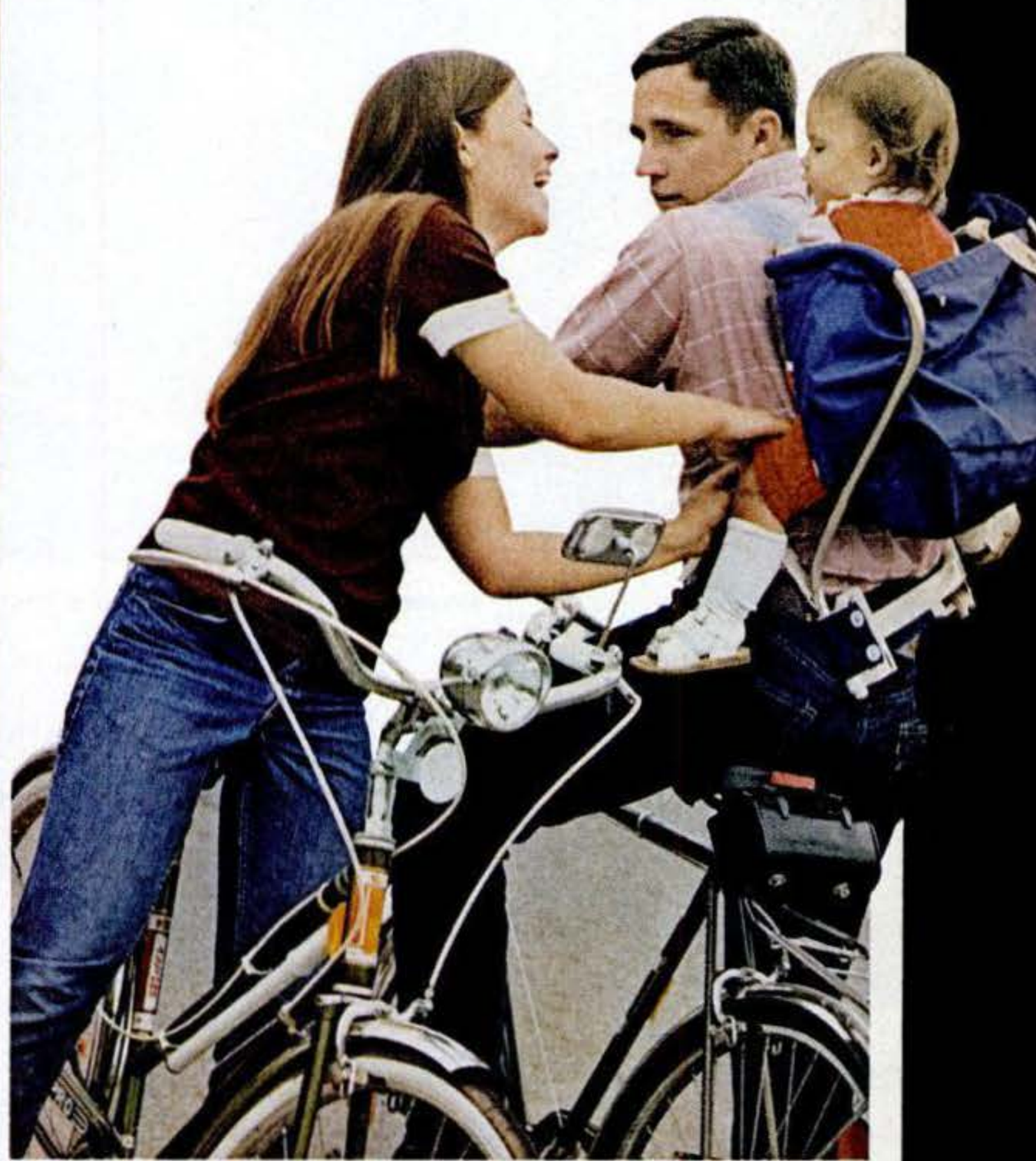

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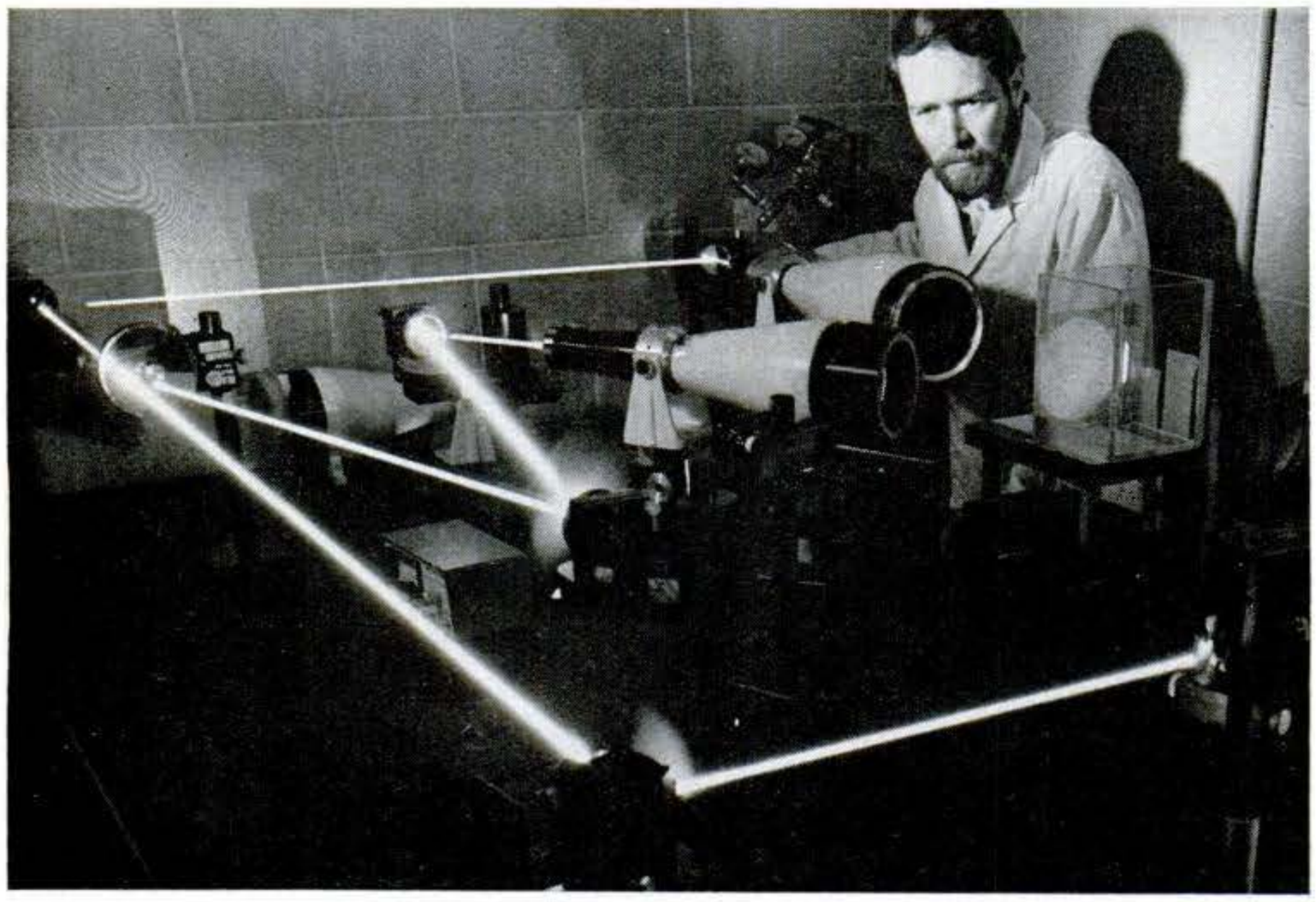
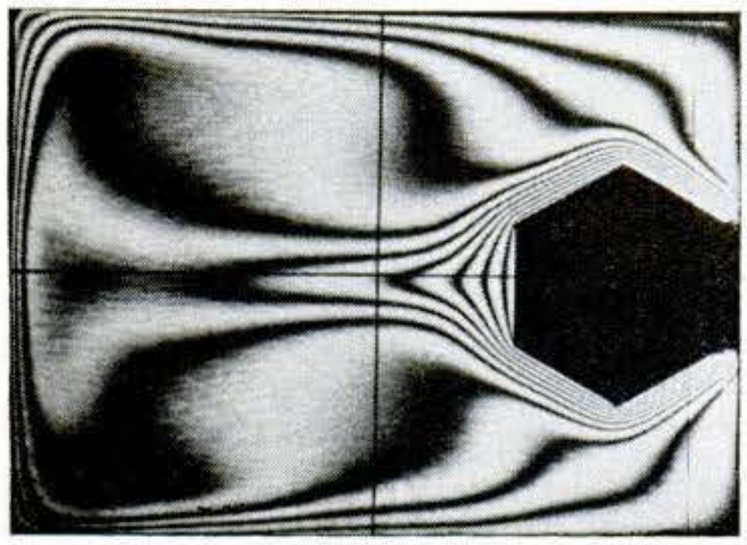
SCIENCE NEWSFRONT

BY ARTHUR FISHER





Clues from double exposures

Holograms are lensless photographs made by laser light. They've been used for everything from "magic" displays to tire-stress analyses. Now researchers at Sandia Laboratories are making double-exposed laser holograms to help them design containers destined to store and transport "hot" nuclear materials. The double exposures show not only the object being probed—a model of a nuclear-fuel cask, for example—but also the heat-transfer patterns within it.

The top photo shows the complex laser pathway and its associated equipment, presided over by Walt Schimmel. The object under test is placed in the transparent box at his side, and a holographic image is recorded on a photographic plate.

The object being tested here is a six-inch-long, one-inch-wide hexagonal tube that is simulating a spent-fuel assembly. After the first holographic image has been recorded, the object is heated to the temperature that would actually be encountered in a real spent-fuel assembly—and a second hologram is recorded on the plate.

You see the resulting double exposure in the bottom photo. The alternating light and dark lines, called fringes, are caused by interference between the two slightly differing laser images. That difference, in turn, is caused by heating the object. The black lines represent areas of constant temperature. Where the black lines are separated by wide white lines, there is little heat transfer, but closely spaced, narrow fringes show much heat transfer, and thus indicate the need for additional shielding, or for a better location of the fuel elements or radioactive waste material within a container. Schimmel says the holographic technique could also prove useful in designing solar collectors, coal gasifiers, and other energy converters in which heat transfer plays an important role.

Automatic crash protection

A new U.S. Department of Transportation survey shows that the death rate in Deluxe Model VW Rabbits with the automatic shoulder belt is about one-third the death rate in other VW Rabbits equipped with ordinary seat belts. 'Nuff said?

Oxygen therapy for elderly

A study at the National Institute of Mental Health and the New York University Medical Center suggests that high-pressure oxygen therapy is probably worthless for treating impaired mental functioning in the aged. Elderly Americans afflicted with forgetfulness, disorientation, impaired judgment and intellectual functioning, and shallow, easily changeable moods have thus apparently squandered hundreds of thousands of dollars since the early 1970's on the treatment.

Reactor-safety test

There are 19 nuclear-power reactors of the kind dubbed BWR—boiling-water reactor—now operating in the U.S. In a BWR, water under pressure is boiled by the intense heat given off by the fuel elements in the reactor. The resulting steam drives turbines connected to electric generators.

For years, there has been considerable controversy over the likelihood—and consequences—of a "loss-of-coolant" accident in a BWR [see "The Hassle Over Atomic-Energy Safety, PS, Sept. '73]. The reactor core of every BWR in the U.S. is surrounded by a pressure-suppression system designed to withstand the forces that computers predict could be unleashed in such an accident (none have yet occurred).

Now there are tests under way to determine how such a system would actually perform in an emergency. The photo below shows a one-fifth scale, quarter-section replica of the Mark I pressure-suppression system that is installed at the University of California's Lawrence Livermore Laboratory. The unique test facility, funded by the Nuclear Regulatory Commission, simulates a loss-of-coolant accident and monitors the pressure load that would be placed on the system. The results will be used by the NRC to evaluate current BWR designs and to help in establishing licensing requirements for the future.

Ion drive bests solar sail

Last July in this space I described a solar sailer—a seemingly fantastic vehicle that was being seriously considered by NASA. The giant, kitelike craft would

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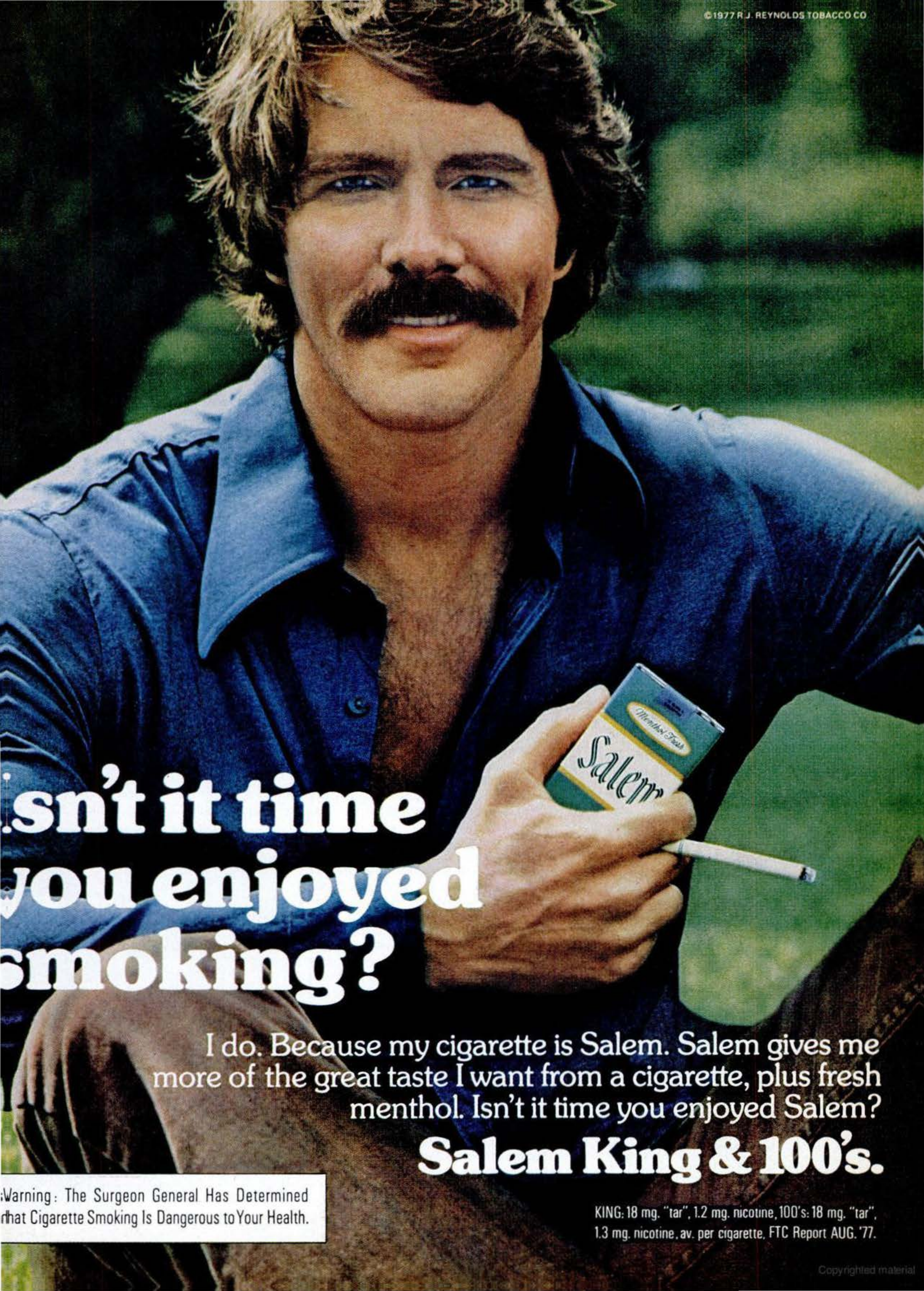

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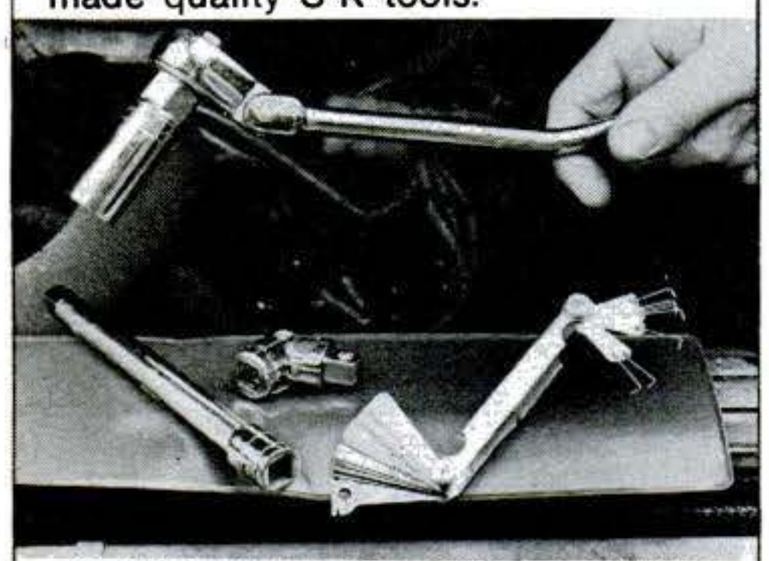

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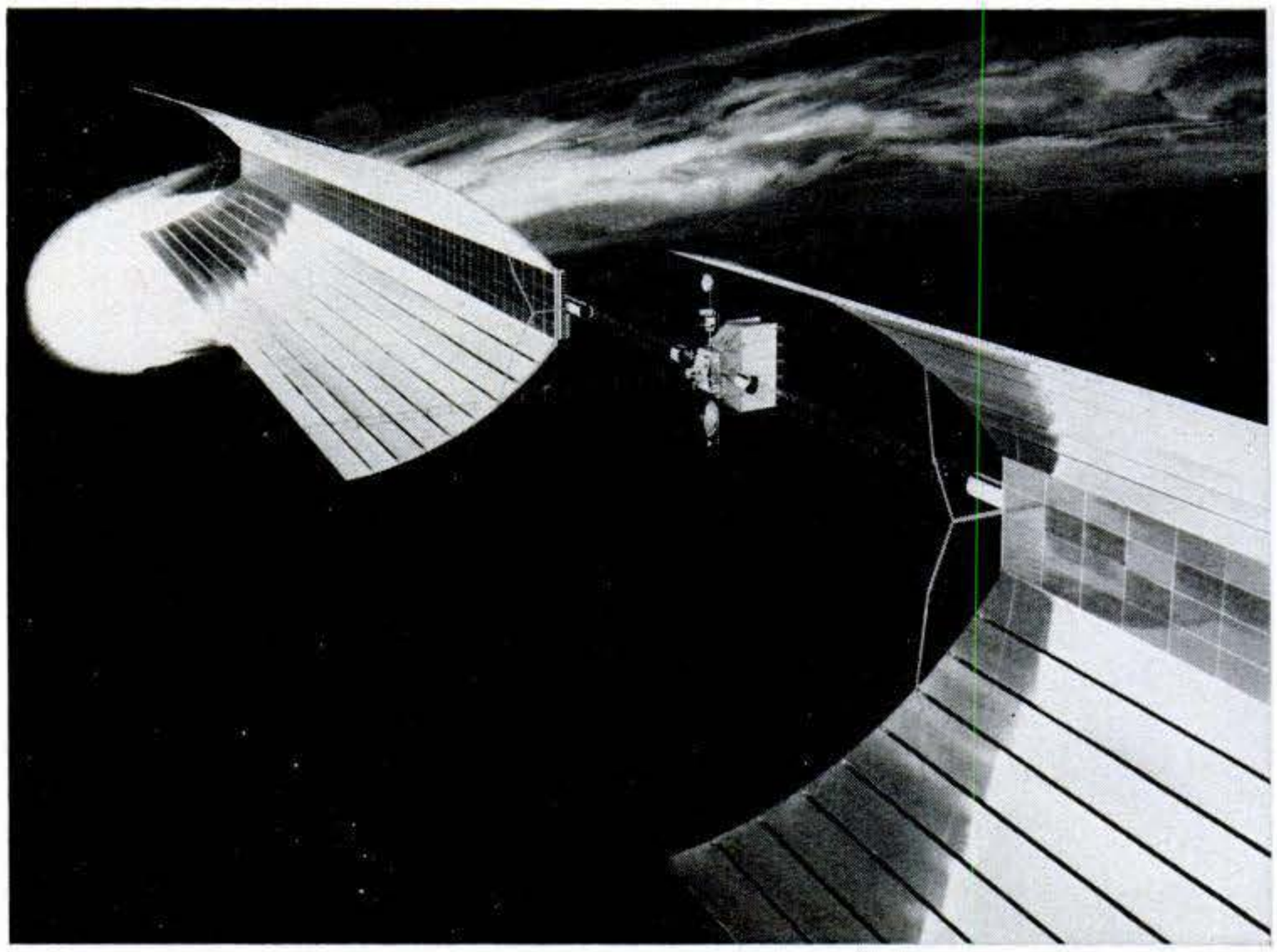


have been sent into solar orbit from the space shuttle sometime in the early 1980's for a variety of interplanetary missions—including, perhaps, a rendezvous with Halley's comet, which is due to revisit the solar system in March 1986. Power source for the sail: the phantom pressure of sunlight itself.

But at the same time designs for the solar sail were being developed and examined, a parallel project was considering a rival means of propulsion—ion drive. And now, after a year's evaluation by scientists and engineers at NASA's Jet Propulsion Laboratory and other research facilities, a decision has been reached: An ion-drive system will propel shuttle-launched automated spacecraft among the planets in the 1980's and beyond.

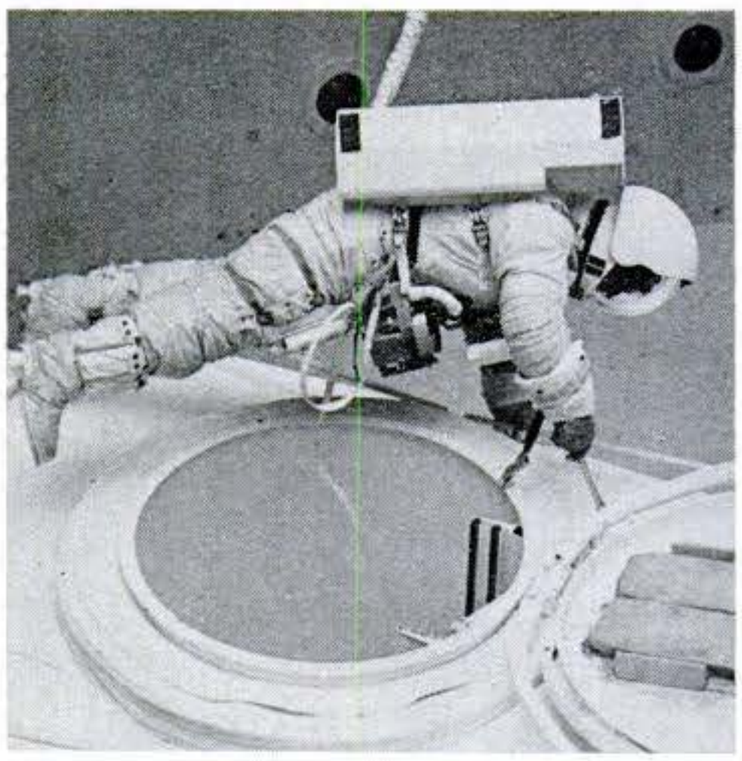
Both propulsion methods are well suited for the kinds of long-term, low-thrust missions NASA's planetologists have in mind. The ion drive was picked, according to a NASA spokesman, mostly because it seemed less risky and offered greater flexibility for the future. And the system has been proved workable; mercury ion rockets have been under development for a decade. In 1969, a series of space-electric-rocket tests (SERT) launched ion rocket engines into Earth orbit, under the aegis of NASA's Lewis Research Center. These predecessors of an ion-drive craft are still being regularly operated in space.

The proposed ion-drive spaceship appears in an artist's concept, shown above, of a comet-rendezvous mission. The two enormous scoop-shaped solar arrays, each some 240 feet long, consist of solar-cell modules, as thin as a single sheet of paper, attached to an ultrathin backing so that the whole array can be unfurled from a circular drum like a window shade from a roller. Because the solar cells must generate enough electricity even when very far from the sun, where the intensity of sunshine is low, the NASA engineers plan to use concentrators.

The electricity thus generated from sunlight feeds a cluster of mercury ion engines, where a steady spurt of ionized mercury vapor is spewed out. It is this stream of heavy ions that provides the low but continuous thrust for the spacecraft.

Spacelab door jam

That's astronaut Paul Weitz testing a solution to what could be a sticky problem in 1983 or so: What happens if the airlock door on the space shuttle's spacelab jams open? Answer: jettison the door



so the shuttle's cargo-bay doors can close over the lab. Weitz successfully performed the test in the Neutral Buoyancy Simulator at NASA's Marshall Space Flight Center located in Huntsville, Ala. The simulator is a huge tank 75 feet in diameter, and filled with water to a depth of 40 feet.

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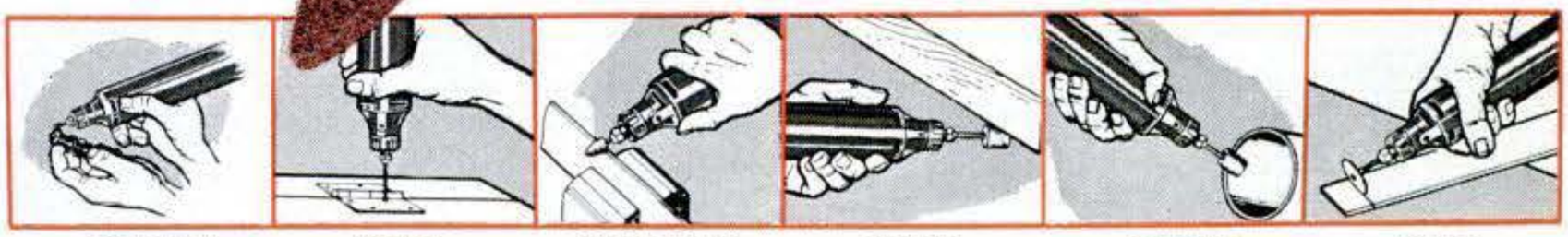

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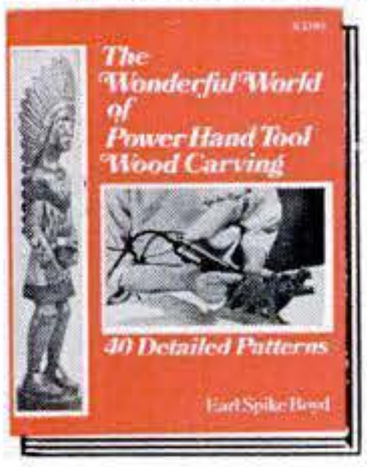

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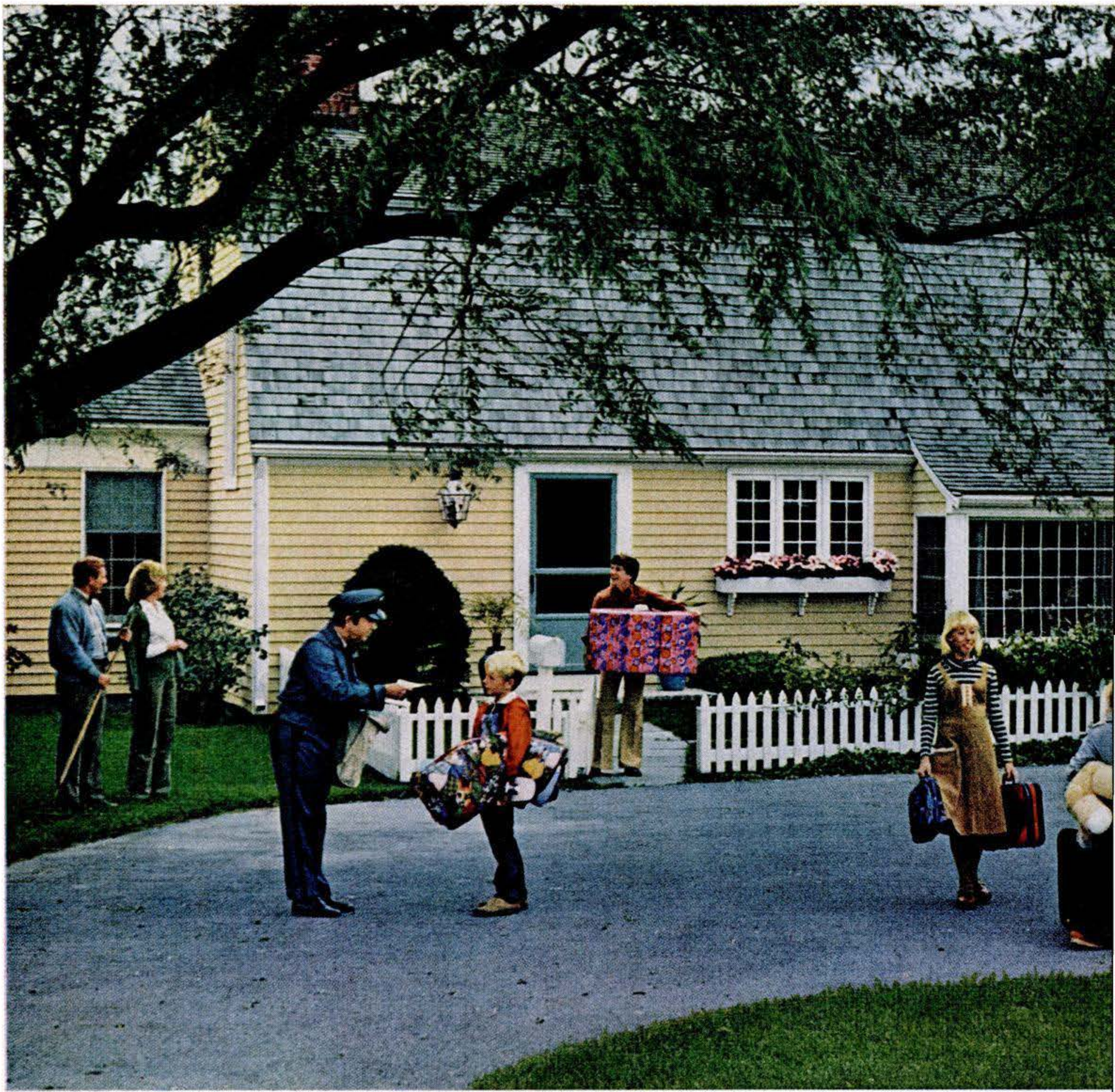

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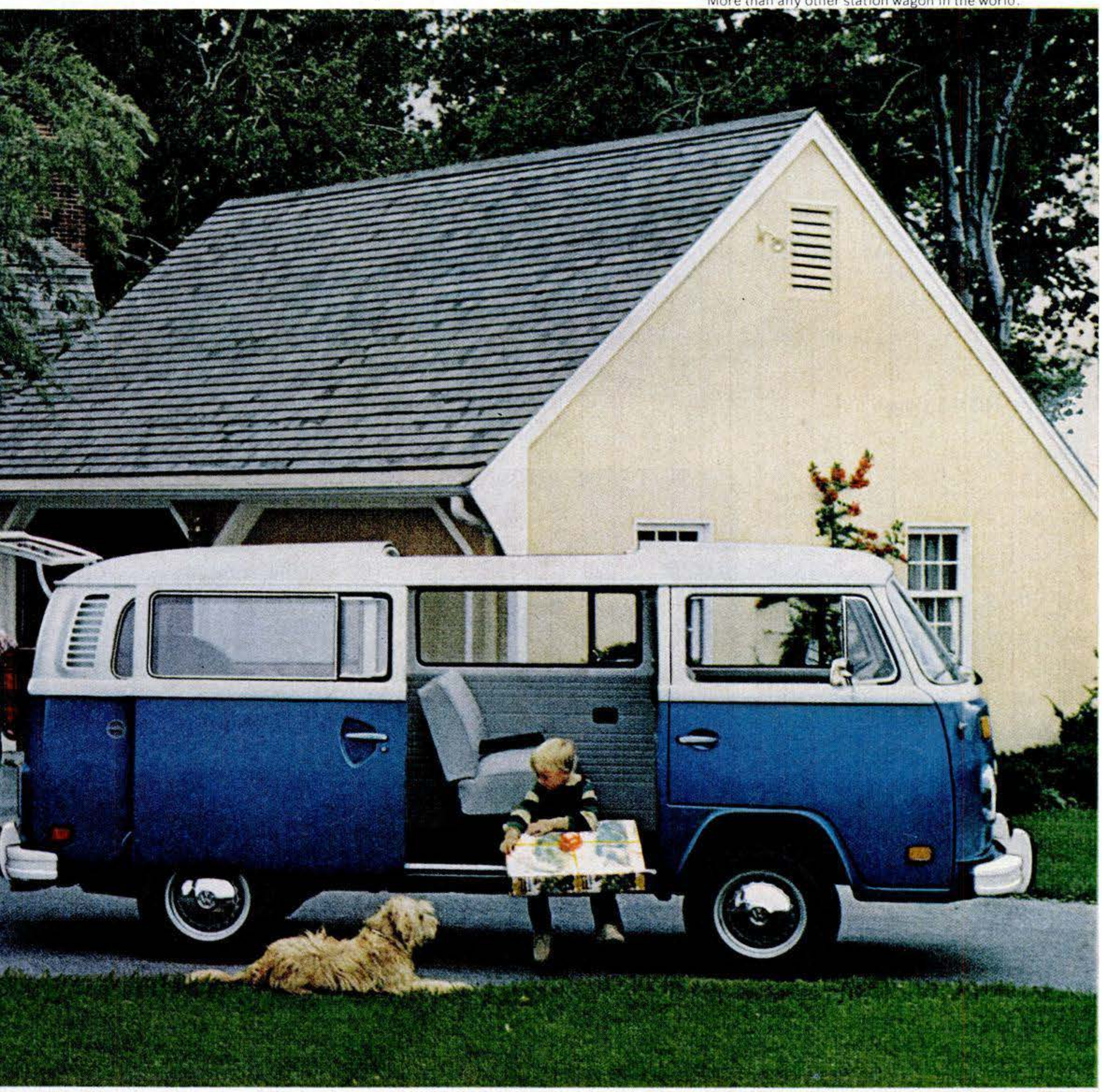

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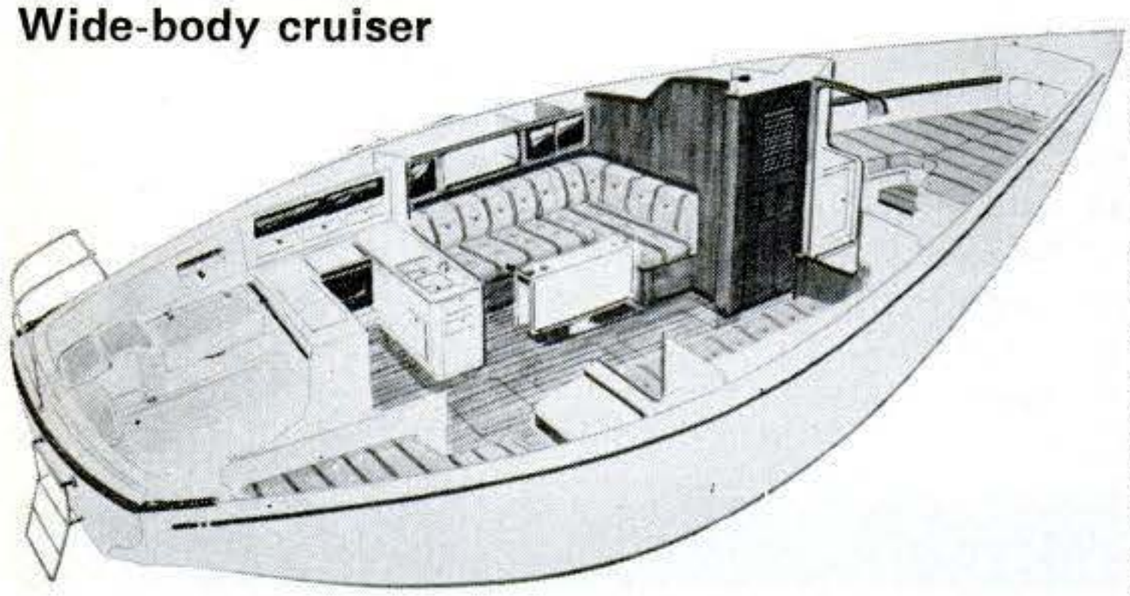
By BOB BLACK

Wide-body cruiser



A new Columbia 25' sailer with 9'2" beam, the "7.6 Meter," is designed for those just getting started in sailing and for the family that likes weekend cruising and club racing.

Australian Alan Payne (an America's Cup yacht designer) has cranked in enough space to sleep four comfortably in a forward V-cabin and on a queen-size double extension berth in the main cabin. She flies 319 sq. ft. of sail, and standard auxiliary power is a 20-hp two-cylinder diesel. The price: $12,500. Columbia is at 2600 Yacht Drive, Chesapeake, Va. 23320.

Where is NOAA now?

Alive and well and putting our tax dollars to some good use.

The National Oceanic and Atmospheric Administration (Department of Commerce) now has improved color formats for all new nautical chart editions, has revised more than 500 charts, and has increased the NOAA Weather Radio stations from 60 to 135.

Land and water printing colors on NOAA charts have been changed from solid yellow and light blue to a screened gold and screened green-blue, respectively. You can distinguish more easily between the new colors, and the resulting green—obtained by overprinting the gold and green-blue for the low-water areas—is significantly improved when viewed at night under "red light" illumination.

For an updated listing, write to National Ocean Survey Publications for Safe Navigation, Distribution Division (C44), National Ocean Survey, Riverdale, Md. 20840. It's free.

Race the wind

Normally we don't report race results in this space, but one of special note is the recent victory by Tony DiMauro of Norwalk, Conn., in the competition for the coveted "Little America's Cup" for C-Class catamarans.

DiMauro's Patient Lady III, which can sail faster than virtually any other class boat in the world, is a wing boat [PS, Aug. '74; Nov. '74, p. 69]. The boat has no sail, *per se;* rather, a wing with ailerons, that is rigged vertically instead of horizontally, as on an airplane.

When asked if it was worth the 15 years and $200,000 spent attaining the International C-Class Catamaran trophy, DiMauro replied, "You bet it was. I spent the last 15 years being a bridesmaid."

The fun of this whole project is that the C Class is truly a development class, and as long as the mast, beam, and length stay constant, the rest is up to the dreams of the designer. All sorts of material—Kevlar, epoxies, you name it—can be used.

DiMauro is looking for foreign challenges from Australia, New Zealand, and several European nations for the next championship races, to be held at Roton Point Club in Rowayton, Conn., perhaps as early as next fall.

Family fishing machine

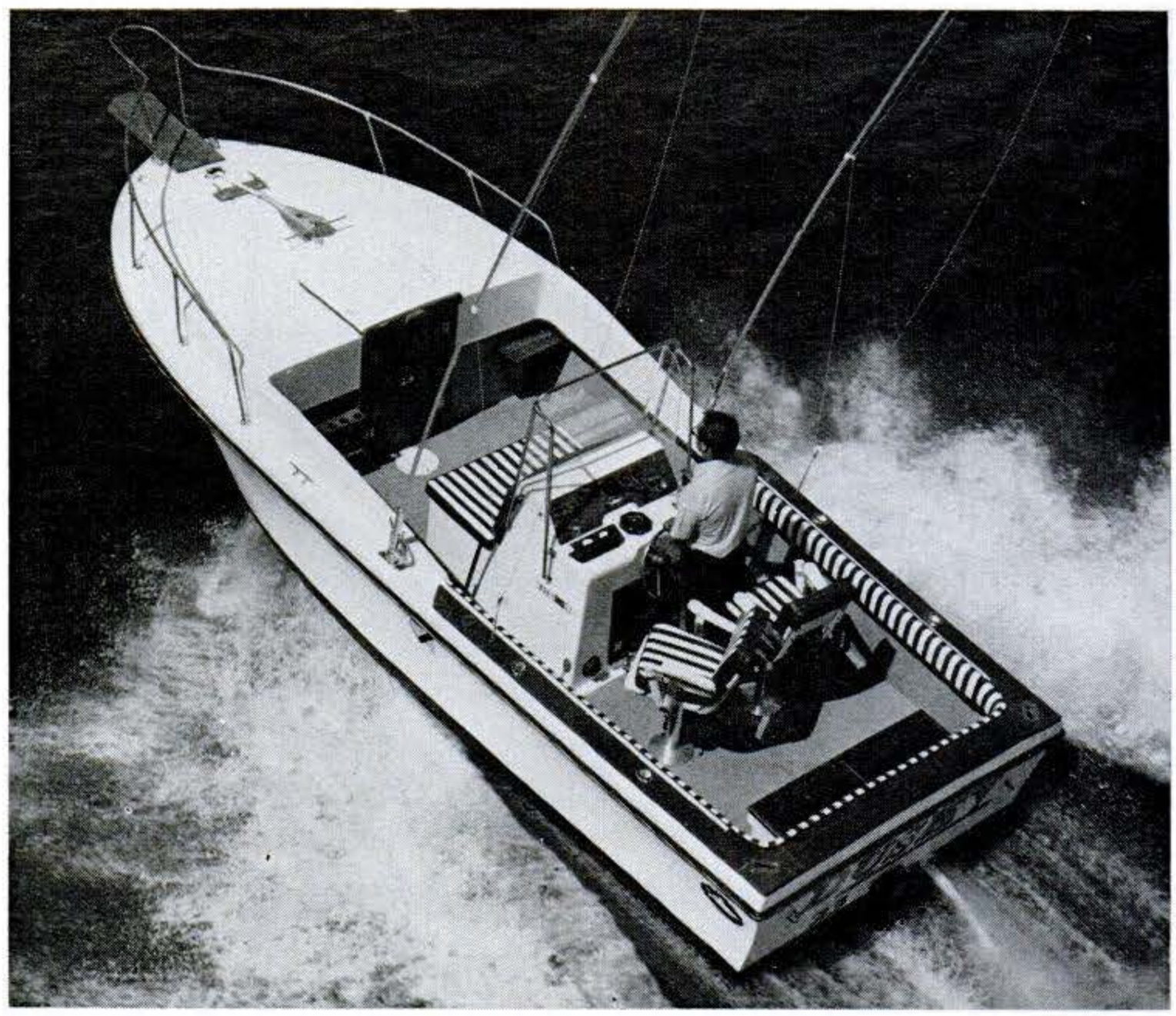
Dusky Marine has come up with a new 23' Cuddy (below) with a center-console command station that gives the fisherman 360-degree fishing-fighting room as well as strategically located controls. Twin 6' V-bunks provide comfort below. The boat is priced from $7350 with 175 OMC stern drive; the version in the photo, with a 225-hp Commander inboard, is $8350. Dusky Marine is at 110 N. Bryan Rd., Dania, Fla. 33004.

Short takes

● With upcoming changes of Coast Guard regulations on boat lights (due to be enforced next August), a new book by D. A. Moore, *International Light, Shape and Sound Signals,* makes good winter reading.

New international regulations—which became effective in mid-1977, together with metrication—have brought about a number of changes in the positioning, ranges, and types of lights and shapes that are required at sea. The book has lots of diagrams in full color. Price is $7.95 from Van Nostrand Reinhold, 450 West 33rd St., New York, N.Y. 10001.

● Knot another one! Well, yes. Here's a great handbook for sailors: *The Art of Knots,* written by Frenchman Marc P. G. Berthier, who specializes in drawing and writing on nautical subjects. The book is light in tone but thorough in content, and has been received enthusiastically in Europe. Now Doubleday (245 Park Ave., New York, N.Y. 10017) has published the book in the U.S. at $6.95. It's beautifully illustrated. PS



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'Tis the C.C. Season!

Time for that spirited holiday cheer that C.C. is famous for. And now, for the holiday season, C.C. comes beautifully gift-wrapped at no extra charge.

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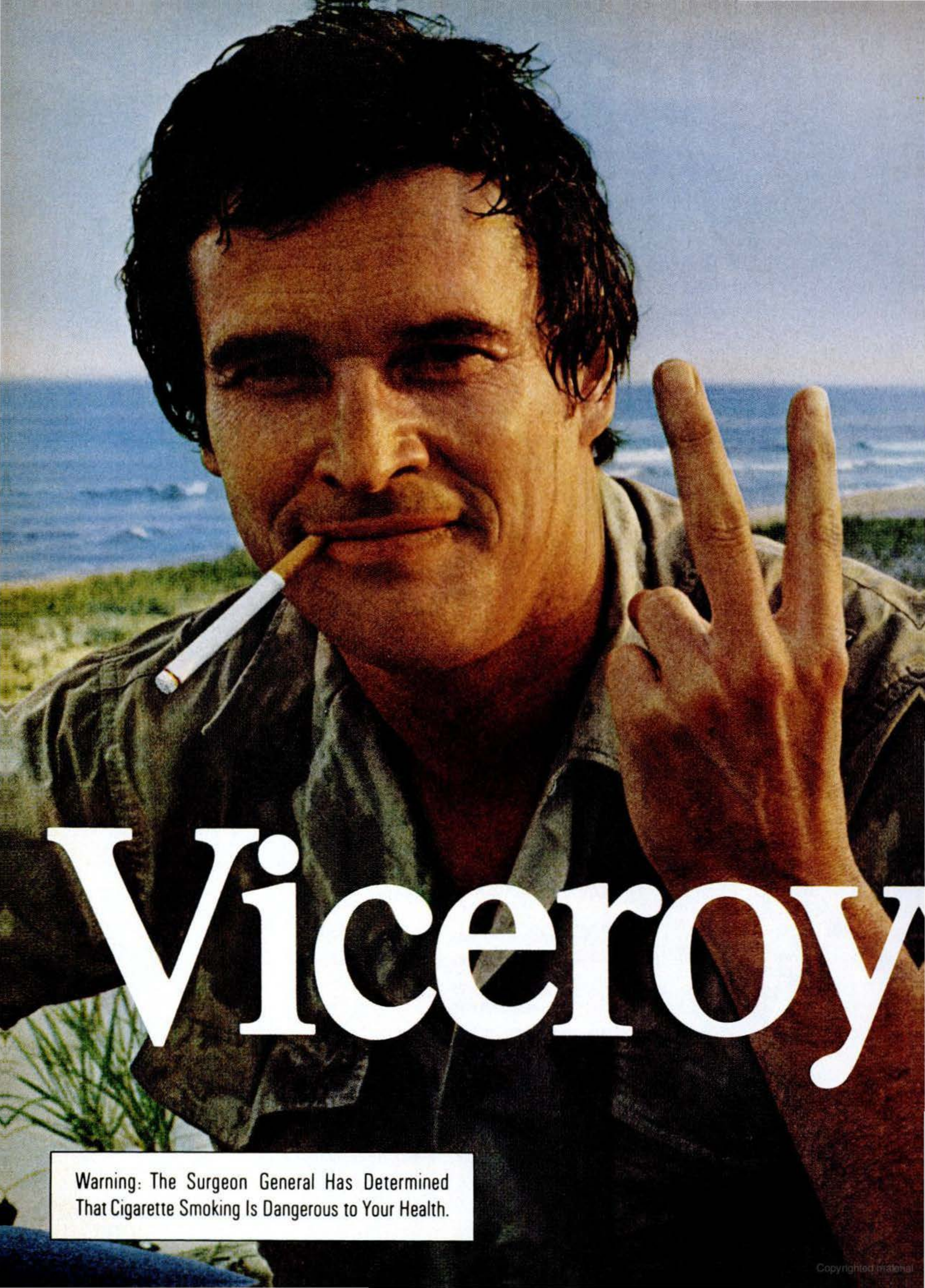

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86 mg. "tar", 1.0 mg. nicotine av. per cigarette, FTC Report Aug. '77

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More Tobacco Less 'Tar'

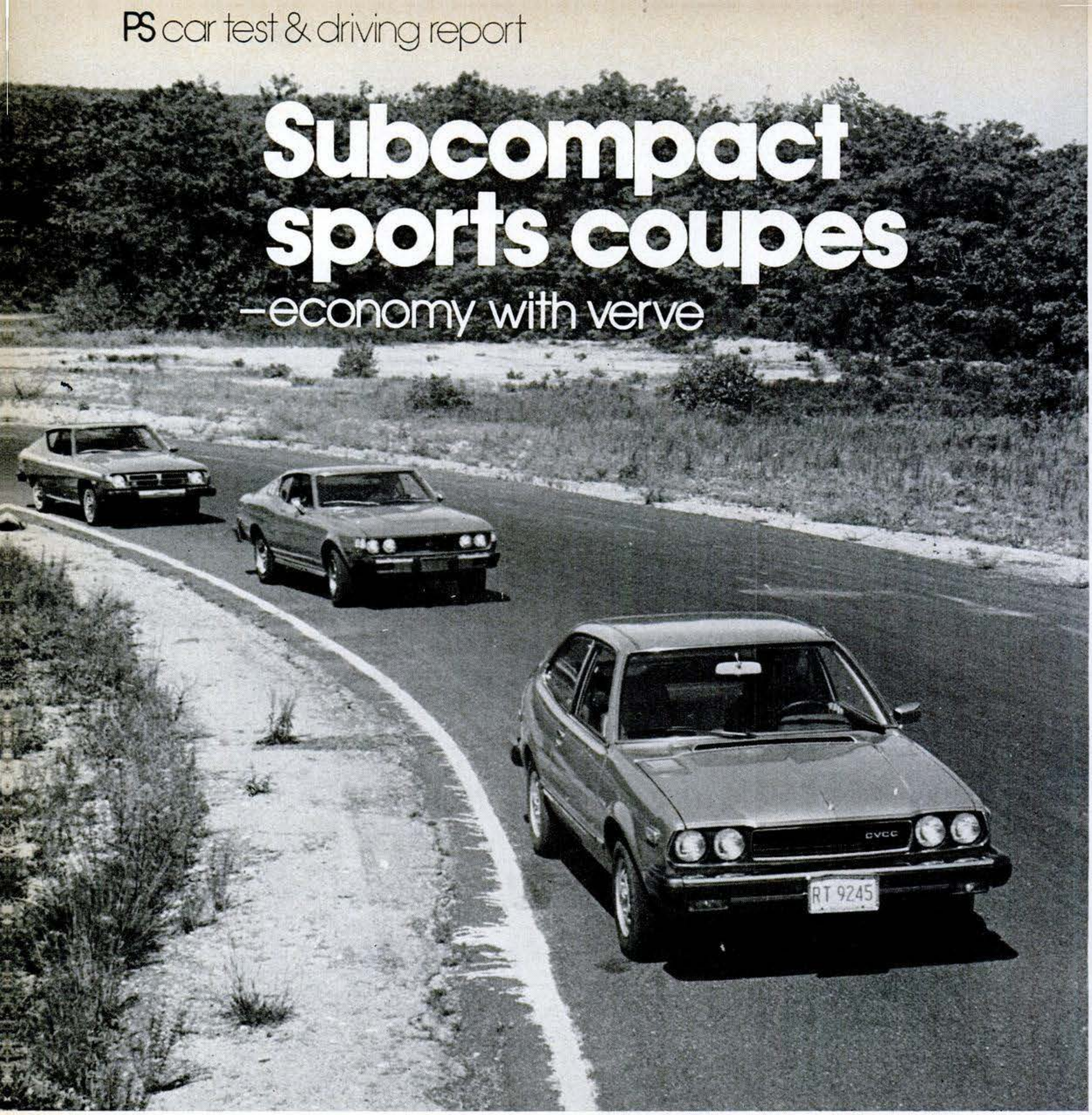
...than Winston or Marlboro.

Rich, full flavor is the promise that Viceroy makes.
And it's a promise that Viceroy keeps.
The method for delivering flavor is as simple as it is smart.
Instead of using stronger tobacco, Viceroy uses *more*[1] tobacco, and a *lower*[2] 'tar' blend than Winston or Marlboro.
The result is a mild, fully packed cigarette with an extra satisfying taste.
And, yes, lower 'tar' than Marlboro or Winston.

1. DURING 1976, VICEROY KINGS HAD, BY WEIGHT, 22-35 MGS. MORE TOBACCO THAN WINSTON KINGS AND 40-52 MGS. MORE TOBACCO THAN MARLBORO KINGS (AVERAGE PER CIGARETTE).
2. VICEROY HAS A UNIQUE, AGED-BLEND OF NATURALLY LOW 'TAR' TOBACCOS AND A SPECIAL PROCESS THAT ALLOWS THE USE OF MORE PARTS OF THE TOBACCO LEAF THAT ARE LOW IN 'TAR'. (VICEROY 16 MGS. 'TAR', WINSTON 19 MGS. 'TAR', MARLBORO 17 MGS. 'TAR', AVERAGE PER CIGARETTE, FTC REPORT, AUGUST, 1977.)

Subcompact sports coupes

—economy with verve



Three popular sports coupes—(front to rear) Honda Accord, Toyota Celica GT Liftback, Datsun 200 SX—offer a host of standard equipment, handsome interiors, good handling, sporty looks, and excellent economy at a reasonable price.

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Honda	Toyota	Datsun
Fuel economy	5	3	4
Acceleration	3	5	4
Braking	4	3	4
Handling	4	4	3
Maneuverability	5	5	5
Ride comfort	3	2	2
Quietness	0	0	0
Roominess	3	2	2
Visibility	4	2	2
Entry/exit ease	2	3	1

By JIM DUNNE and RICH CEPPOS

Remember the pony cars of the late Sixties? The Mustang, Camaro, Cougar, Firebird, Barracuda, Javelin, and Challenger were aggressive-looking, fun-to-drive compact sports coupes that cost about as much as an intermediate sedan. But skyrocketing gas prices and decreasing performance due to emissions requirements have thinned the pony-car ranks to the point that now only two models remain: the Pontiac Firebird and Chevrolet Camaro. A new generation of affordable fun

Continued

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Now more than ever, you need the car-buying facts in this free book.

If you plan to buy a new car, you'll find that many '78 models have new names. And many established names are coming in new sizes. Making a choice could be confusing.

So how do you choose the car that's right for you? How do you match your personal needs to the best combination of size, body style, standard features and options?

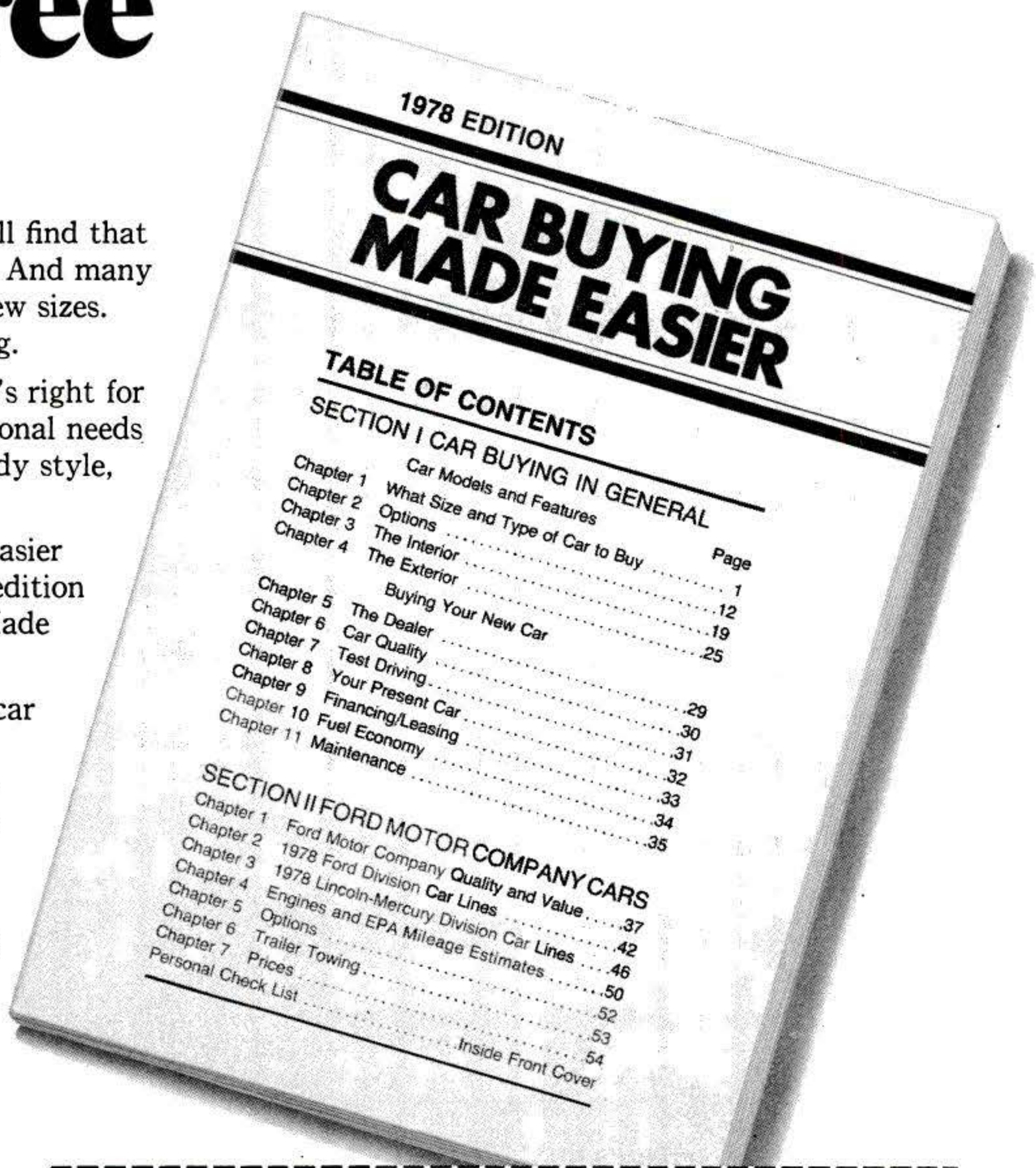
We want to make these decisions easier for you so we've written the 1978 edition of our handy book "Car Buying Made Easier." And it's yours free.

The first section of the book is on car buying in general. The new body styles, sizes, standard features and options are all explained . . . along with their advantages and disadvantages.

The second section is all about the 1978 Ford, Mercury and Lincoln cars. The models are shown with all the information you need . . . on standard features, available options and suggested retail prices.

There's also a detachable, pocket-size personal checklist to take with you when you go shopping. It's there to help you plan your purchase—before you talk to a salesman.

"Car Buying Made Easier" is 112 pages of easy reading facts and information that can make buying a new car in 1978 a whole lot less complicated. And it's yours free. Send for it today.



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FORD MOTOR COMPANY
P.O. BOX 1978,
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DEARBORN, MICHIGAN 48121

Mr. ☐ Mrs. ☐ Miss ☐ Ms. ☐ Dr. ☐

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coupes has sprung up to fill the gap, and they offer sporty looks, handsome interiors, good handling, and economy-car gas mileage.

Three popular examples of this sports-coupe genre are the Honda Accord, Toyota Celica GT Liftback, and Datsun 200 SX. All are four-seaters and come standard with five-speed transmissions, four-cylinder engines, full instrumentation, carpeting, reclining seats, radial tires, and AM/FM radios. But despite their similarities, our side-by-side testing revealed that they offer very different solutions to the same set of requirements.

Honda Accord

The star of our three-way test was the Honda Accord, but you won't find clear-cut evidence of that in our spec tables. That's because the Accord scored especially well in categories that can't be objectively measured with test equipment. In areas such as interior design, versatility, thoughtful convenience features, and road feel, the Accord was far above the other two test cars and better than many other cars we've recently tested.

The Accord's interior feels airy and spacious, a result of acres of glass, a low belt line, and the absence of a drive-shaft tunnel—thanks to the Accord's front-wheel-drive layout. In the center of the clean and functional instrument cluster is the Electronic Safety Diagram, a graphic display showing an outline of the Accord as seen from overhead. Appropriate parts of the diagram light up whenever a door is ajar, the hatch is open, or a tail lamp has burned out. Reminder lights on the dash tell you when it's time to change oil, replace the oil filter, or rotate your tires. Other thoughtful touches are the covered coin tray in the dash, a wiper/washer for the rear window, defroster vents in the door panels for the side windows, and a remote hatch release operated from the driver's seat. The flip-down rear seat and hatch door give you an instant station-wagon utility. All of these features are, amazingly, standard on every Accord.

The Accord's interior is roomy enough for four adults to travel long distances comfortably. In this respect it matches the most space-efficient small cars, the Rabbit and Fiesta. Our only complaint is that the driver's seat back is angled too far back, even in the full-upright position. Otherwise, we wouldn't change a thing.

But the best thing about the Accord is the way it drives. The steering is responsive, precise, and so light it feels power-assisted, making directional changes jackrabbit quick. The ride is supple and well-controlled over big bumps and dips, but never bouncy or harsh. And though the Accord is a featherweight 2018 pounds, directional stability—even in crosswinds—is excellent. Overall, the ride and handling of the Accord equal that of the best small cars. The 1600-cc CVCC stratified-charge engine meets all emissions requirements without a catalytic converter, has more than enough punch (0-60 mph in 17 seconds) to cope with any traffic situation, and is surprisingly relaxed at highway speeds. Its mileage is superb: 48 mpg-highway/38-city. In all, the Accord is an all-star car: comfortable on the highway, great fun on winding roads, and effortlessly maneuverable around town as well.

Toyota Celica

Compared with the state-of-the-art Accord, the front-engine/rear-drive Toyota Celica GT Liftback seems a bit dated, and indeed it will be replaced by an all-new model by

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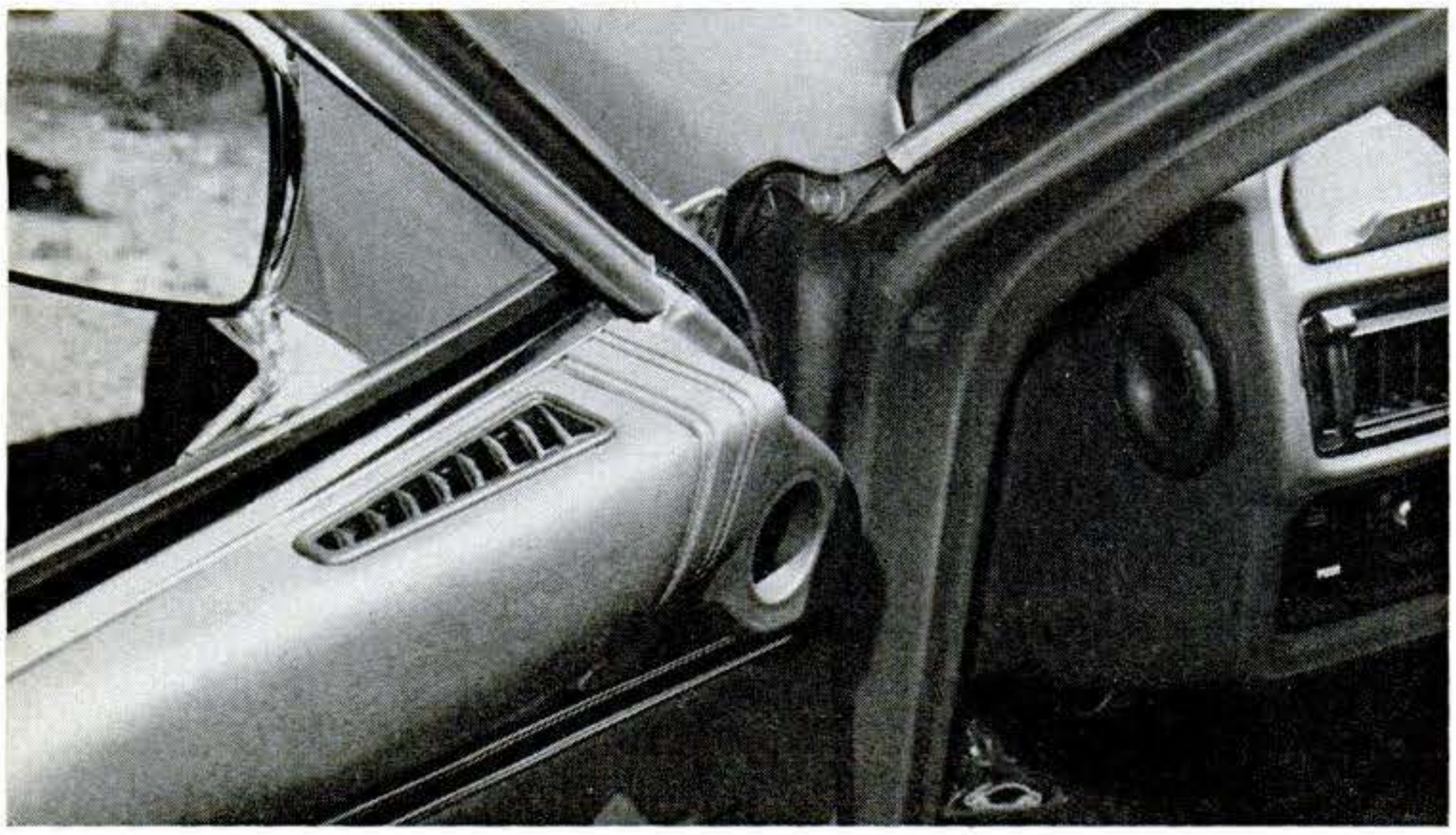

EPA fuel mileage (mpg)

	Honda	Toyota	Datsun
Highway	48	37	34
City	38	21	23
California highway	47	35	32
California city	33	19	23

Side-window defogger in door panel and covered coin tray are two features on Honda that the others don't have. Carpeting, reclining seats, AM/FM radios, and more are standard on all three cars.

Toyota, below, proved fastest of test cars in acceleration, and as fast as some V8 cars PS has tested. Fastback styling reduces head room so much that back seat isn't comfortable for adults.

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Merry Smoothness.

SMOOTH AS SILK
KESSLER

JULIUS KESSLER CO., LAWRENCEBURG, IND. BLENDED WHISKEY. 80 PROOF. 72½% GRAIN NEUTRAL SPIRITS.

Low steering effort and supple, well-damped suspension make Accord fun to drive on twisty roads, and quick and controllable through PS high-speed accident-avoidance lane-change maneuver.

Honda's hatch door has standard remote release and wiper/washer. Our only complaint about interior is that with reclining seat in full-upright position, you're still leaning back too far.

the time you read this. The handsomely finished interior feels much more constricted than the Accord's because of the Celica's lower fastback roofline and smaller glass area —though up front there really is as much room. You can't see out as well as in the Accord.

The Celica's interior is further compromised by an uncomfortable rear seat. Your head hits the roof over bumps and there isn't enough room for your knees unless the front seats are pushed well forward. Adults will be uncomfortable in the back of the Celica for anything but short trips. As in the Accord, you can flip down the rear seat and turn the Liftback into a useful mini-wagon. The Toyota also features an LED-type display that informs you of low fluid levels.

In objective terms, the Celica's performance and handling are as good as the Accord's. It corners as well, changes lanes in an emergency situation as quickly, and stops in about the same distance. Its 2.2-liter engine will leave the Honda in the dust.

But the Toyota doesn't feel as light on its feet as the Accord, largely a result of the effort required for steering. Its suspension also seems slightly anesthetized by comparison, providing less road feel than the Honda's. But it does have enough cornering grip and power to be fun on curvy country roads. The ride is well controlled over all surfaces; in fact, highway cruising is the Celica's strong point. The engine just loafs in fifth gear at 55 mph, directional stability is good, and the comfortable driving position and seats make it easy to relax.

PS serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Honda	Toyota	Datsun
Checking fluid levels:			
Battery	4	4	3
Master cylinder	5	5	5
Windshield washer	5	5	5
Engine oil	5	5	5
Coolant	5	5	3
Checking engine:			
Spark plugs	5	5	5
Distributor	5	5	3
Carb adjustment	3	3	3
Oil filter	5	3	4
Oil fill	5	5	5
Replacing hoses:			
Top radiator hose	5	5	4
Lower radiator hose	4	5	3
Heater hoses	4	3	3
Changing bulbs:			
Headlights	3	3	3
Taillights	3	2	2
Front running lights	3	2	2
Front parking lights	2	3	3
Front directionals	2	3	3
Rear directionals	3	2	2
Rear running lights	2	2	4
Checking fuses	3	5	4
Spare-tire accessibility	5	5	3
Changing belts	3	3	2

Datsun 200 SX

A relatively new entry in the sports-coupe market, the Datsun 200 SX is much like the Toyota in design and performance, though it's not a hatchback, surprisingly, but a standard sedan. Like the Toyota's, the interior is comfortable for two and the back seat is too small for anything but short trips.

The interior features basically the same equipment as the Toyota, with none of the thoughtful touches of the Honda. Straight-line performance and fuel mileage are very close to the Toyota's, and almost everything mentioned about the Toyota's ride and handling apply directly to the 200 SX as well. The one big difference between the two, besides styling, is that the Datsun's cargo capacity and versatility are severely limited by its oddly shaped, conventional trunk. The Datsun's gas tank is behind the rear seat, leaving a cavity that is very deep but also short.

But cargo capacity aside, the Datsun 200 SX and Toyota Celica Liftback are both good cars at a reasonable price. The Honda Accord's sophisticated drive-train layout, clever features, sedan-like interior room, fine manners, and low price have made it one of the most sought-after cars in recent American automotive history.

Demand for the Accord is so high that buyers will often pay premium prices—hundreds of dollars above sticker price—to get one. This situation has been unheard of since the car-hungry days after World War II, and it reinforces our belief that the Honda Accord is truly a great bargain. PS

For specs and test results, turn page

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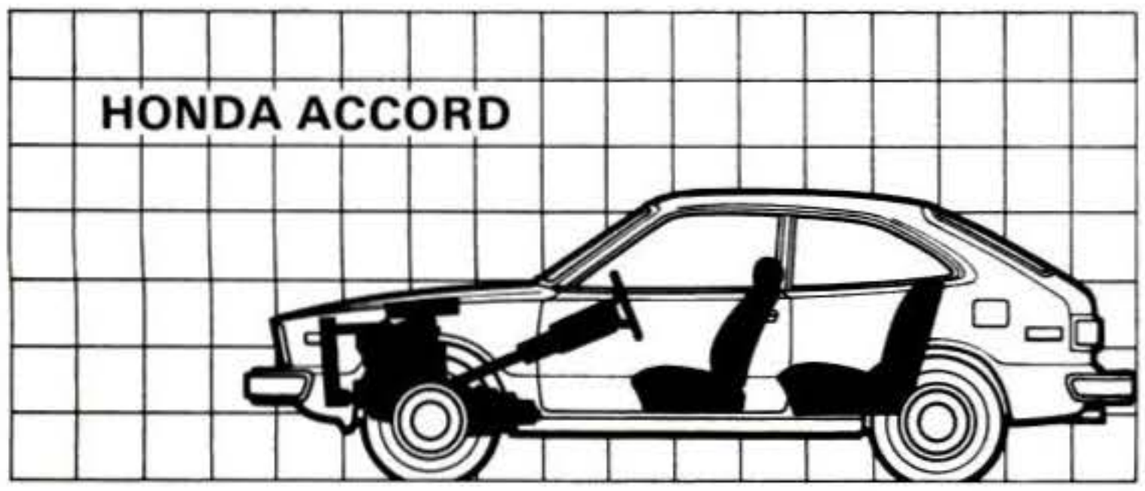

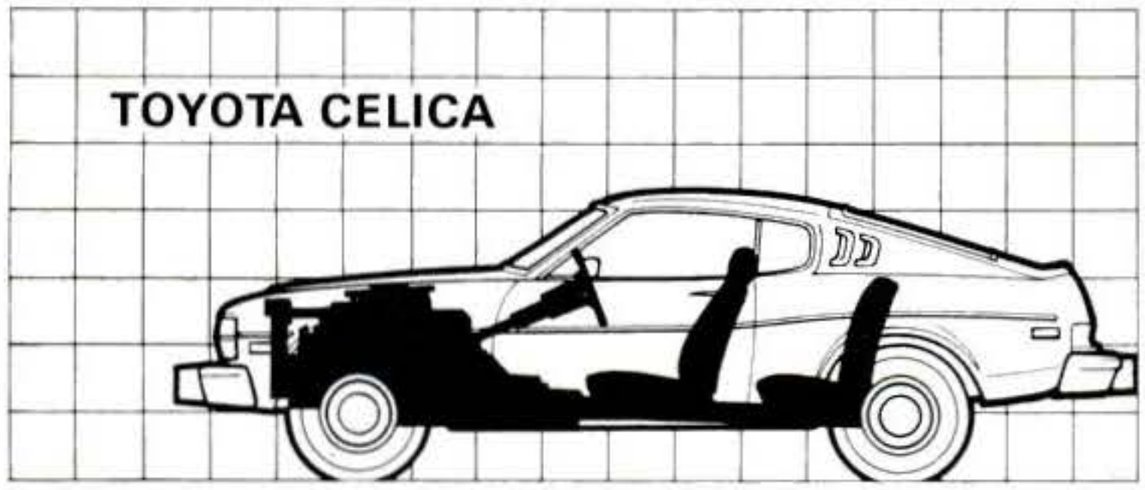

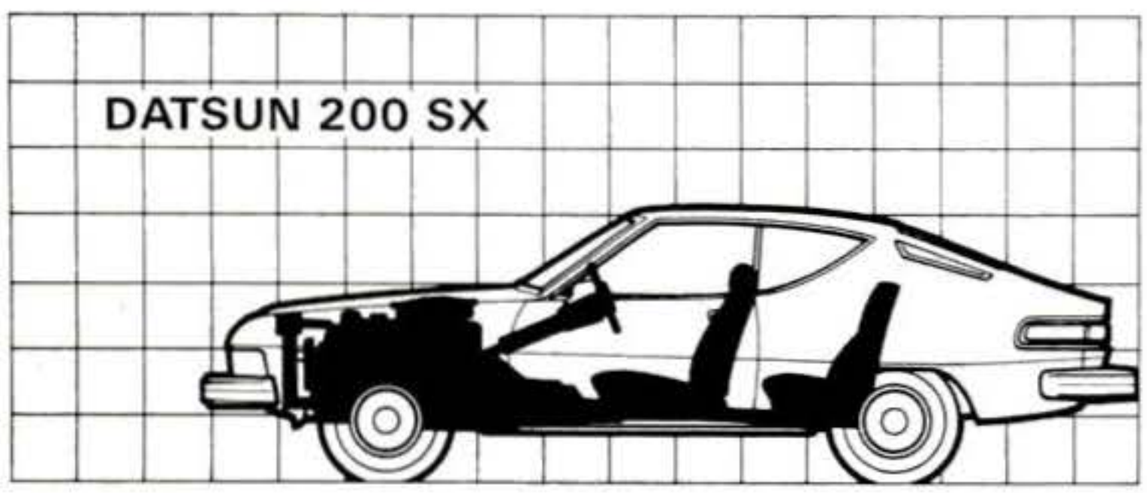

Accord, top, with FWD layout and tall greenhouse, carries four adults comfortably. Toyota has insufficient rear-seat head room due to low roofline. Datsun is least versatile as it is not a hatchback and has a very small trunk.

Performance comparison of selected 1976, 1977, and 1978 models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 mph (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1977 VW Rabbit (diesel)	39	22.0	136	60.0	30.1	75
1978 Ford Fiesta 4	33	15.3	136	62.4	31.1	72
1977 Chevrolet Chevette 4	36	19.9	171	60.0	29.6	74
1977 AMC Gremlin 4	21	17.3	146	62.4	28.1	73
1976 VW Rabbit (gasoline)	24	13.5	115	63.0	30.0	72
1976 Ford Pinto 4	20	15.3	148	58.2	28.6	72
1977 Dodge Aspen 8	15	14.6	178	53.0	23.9	70
1977 AMC Pacer 6	17	15.2	174	56.0	24.6	69
1976 Renault-5 4	28	17.3	181	58.2	28.1	73
1976 Honda Civic 4	35	18.0	134	60.0	28.6	72

Honda, Toyota, and Datsun— specs, dimensions, and test results

	HONDA Accord	TOYOTA Celica GT	DATSUN 200 SX
DIMENSIONS (inches)			
Wheelbase	93.7	98.3	92.0
Overall length	162.8	174.4	170.0
Overall height	52.4	52.0	51.2
Overall width	63.8	63.8	63.0
Track, F/R	55.1/54.7	53.1/51.6	50.4/49.8
Ground clearance	6.5	7.0	6.0
Front head room	36	35	35
Front hip room	46	44	40
Front leg room	45	42	46
Rear head room	34	32	32
Rear hip room	50	40	42
Rear leg room (min.)	33	30	28
Min. rear knee room	−1	1	−3
Couple distance	28	32	23
SPECIFICATIONS			
Engine type	OHC 4 in-line	OHC 4 in-line	OHC 4 in-line
Displacement (cu. in./cc)	97.63/1600	134/2189	119.1/1952
Compression ratio	8.0:1	8.4:1	8.5:1
Carburetor	3 bbl.	2 bbl.	2 bbl.
Net hp @ rpm	68 @ 5000	95 @ 4800	94 @ 5600
Net torque @ rpm	85.4 @ 3500	90 @ 4800	102 @ 3200
Transmission	5-speed manual	5-speed manual	5-speed manual
Axle ratio	4.26:1	3.6:1	3.9:1
Tire make	B.F. Goodrich	Dunlop	Dunlop
Tire type	Radial	SP Steel Excel 70	SP Steel Excel 70
Tire size	155 SR-13	185 SR-14	185 SR-14
Steering	Manual rack and pinion	Manual recirc. ball; variable ratio	Manual recirc. ball
Overall steering ratio	17.4:1	19-21.5:1	16.5:1
Turns, lock to lock	3.3	4.2	4.2
Turn diameter (ft.)	32.9	36.0	34.4
Front suspension	Independent MacPherson struts, coil springs, stabilizer bar	Independent MacPherson struts, coil springs, stabilizer bar	Independent MacPherson struts, coil springs, stabilizer bar
Rear suspension	Independent MacPherson struts, coil springs	Rigid axle, coil springs	Solid axle, leaf springs
Emission-control equipment	C.V.C.C. (see text)	E.G.R., air injection	E.G.R., air injection
Brakes	Power assist; disk/drum	Power assist; disk/drum	Power assist; disk/drum
Brake swept area (sq. in.)	212.0	285.7	251.9
Fuel tank (gal.)	13.2	15.3	15.8
Trunk space (cu. ft.)	35.3*	7.7 (27.1*)	5.6
Liftover height (in.)	35.0	37.0	32.5
Curb weight (lbs.)	2018	2610	2365
F/R weight distribution (%)	60/40	54/46	54/46
Trailer-towing	Not rec.	Not rec.	Not rec.
Basic price	$4465	$5139	$4699
Options on test car	None	Air conditioning ($480), all-weather guard ($36)	Air conditioning ($455), sports accent package ($128)
Price as tested	$4465	$5655	$5282
TEST RESULTS			
Acceleration 0-60 mph (sec.)	17.0	14.9	15.3
Acceleration 25-70 mph (sec.)	21.3	15.7	16.3
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	146	162	155
Pedal pressure (lbs.)	60	120	120
Efficiency (% of 1 g)	100	95	100+
Disk temperature (°F)	155	144	215
Brake test (hot) 60-0 mph			
Stopping distance (ft.)	128	150	138
Pedal pressure (lbs.)	100	60	120
Efficiency (% of 1 g)	100+	100++	100+
Disk temperature (°F)	581	519	588
Interior noise @ 60 mph (dBA)	72	72	72
Handling test (mph)	62.4	62.4	60.0
Maneuverability (mph)	28.1	28.1	29.1

TEST CONDITIONS: Ambient temperature 82° F; relative humidity 65 percent; barometric pressure 30.1 inches

*With rear seat folded down

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And KOOL's refreshing coolness, too.

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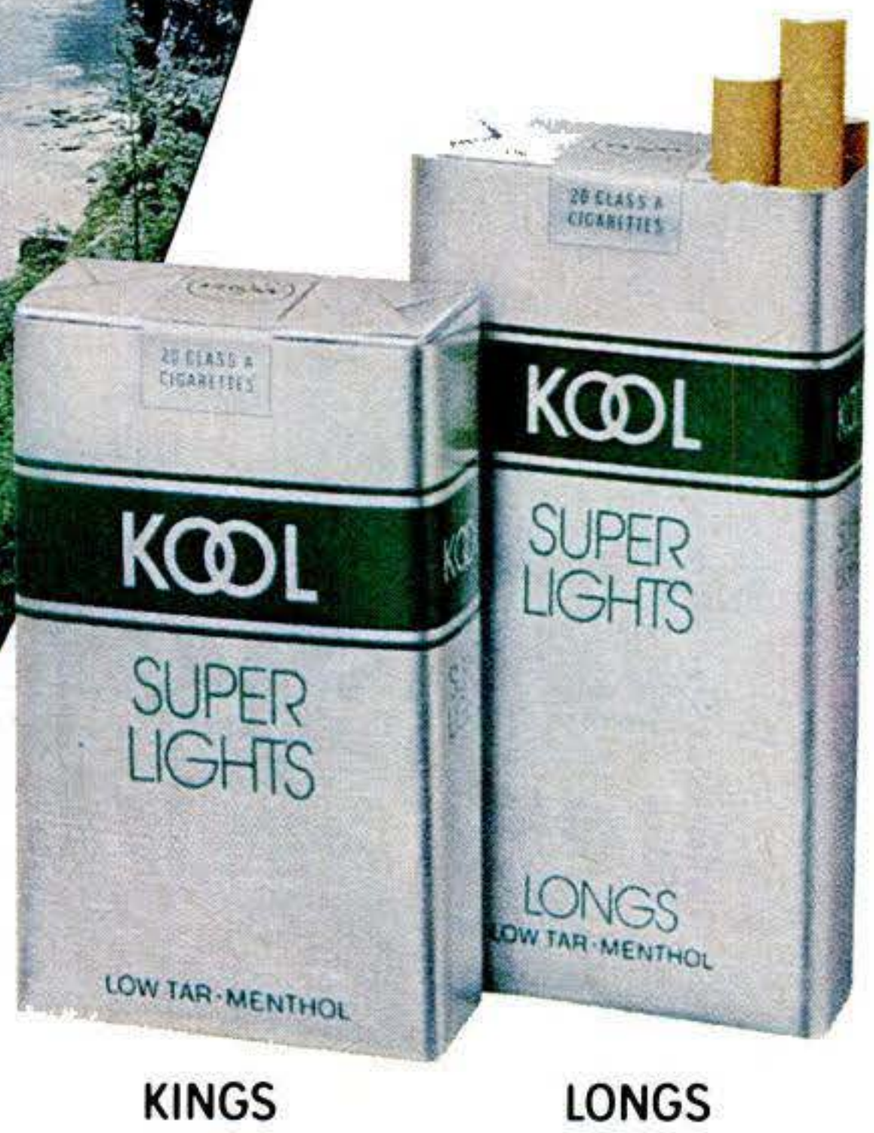

KINGS LONGS

mg.'tar' in both sizes.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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9 mg. "tar," 0 .8 mg. nicotine, av. per cigarette, by FTC method.

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name famous. Flight test one—you'll find
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Power Steering	No Charge
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Full Wheel Covers	No Charge
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Electric Clock	No Charge
Steel-Belted Radials	No Charge
White Sidewall Tires	$ 46
Vinyl Roof	$ 138
Color-Keyed Bodyside Moldings	$ 54
Dual Accent Paint Stripes	$ 46
Deluxe Bumper Group	$ 76
Remote Control Mirror	$ 16
Color-Keyed Belts	$ 21
TOTAL	$5,808*

*Excluding title, taxes and destination charges

THUNDERBIRD

FORD DIVISION

Ford 75th ANNIVERSARY

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THROUGH THE VIEWFINDER

By EVERETT H. ORTNER

At last: automatic focusing

Flip the film-advance lever of the Konica C35AF camera, and you have not only advanced the film 38 mm and cocked the shutter—you have also moved the lens forward to its point of closest focus and wound up a spring that, at this moment, exists on no other camera on the market.

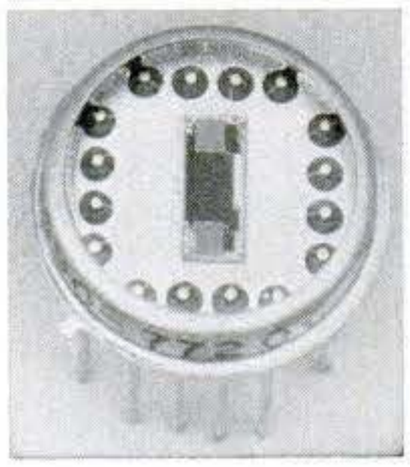
Released when you press the shutter-release button, the spring rotates a rangefinder mirror that simultaneously scans the scene at which the Konica is aimed and moves the lens backward. The movement halts when an electronic module built into the camera tells it that the lens is in focus. Only then, within the 100 milliseconds (1/10 second) that a full scan from nearest focus to infinity would take, does the shutter open to take the picture.

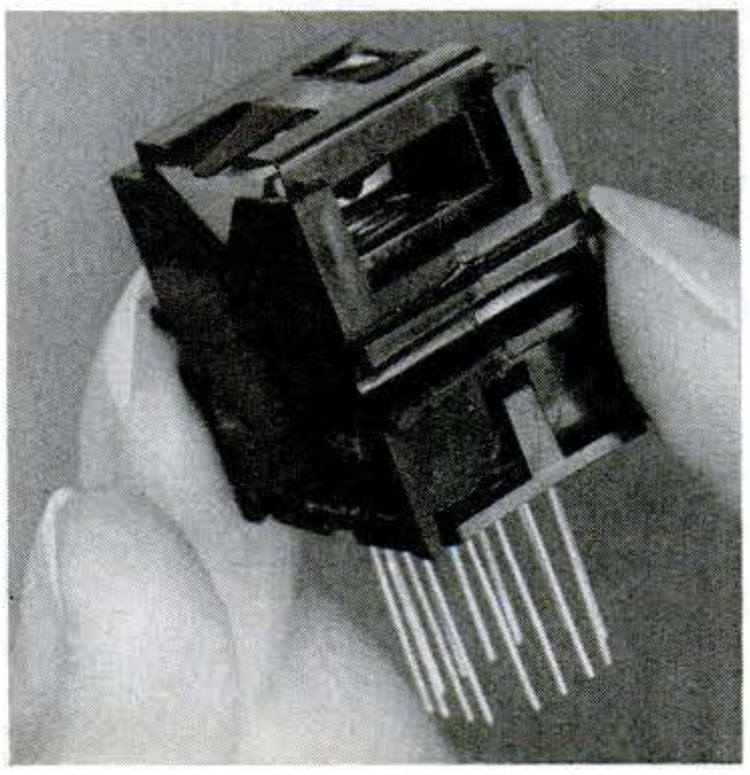
The device that makes this automatic-focusing system possible is the Visitronic Auto-Focus (VA/F) module, designed, manufactured, and marketed by Honeywell. It is the product of 10 years' work by Honeywell scientist Norman L. Stauffer and a small group of engineers. (Stauffer is also the man who, in 1964, invented the slide-projector auto-focus system that is still in use on several projectors, including the Kodak Carousel.)

Two years ago Honeywell invited camera manufacturers to take a look—for an "advance-disclosure" fee of $50,000—at its module. The $50,000 bought technical information, technical support, some sample modules, and the right to buy still more modules from Honeywell. Thirteen manufacturers have now joined the program, reports Ron Brown, Honeywell's marketing manager. Four of them showed prototype auto-focusing units at Photokina, the German photography exposition, last fall: three movie cameras (Eumig, Elmo, and Sankyo) and an SLR zoom lens (Asahi).

The dimensions of Honeywell's success can be gauged by the fact that although both Nikon [PS, Aug. '71] and Canon announced auto-focusing systems, neither got beyond prototypes. Konica deserves credit, too, for being first off the starting line with a production camera. "That Visitronic system has been around for a long time," says Peter Ildau, vice president of Konica Camera Co., "but we're the first to put it in a camera." That took some doing. The camera hardware—a spring motor—is almost as ingenious as the auto-focusing module.

With the Visitronic system in the Konica C35AF, focusing is as simple and automatic as exposing the film with an auto-exposure system. When you advance the film, you rack the lens to its most forward position. When you press the shutter release, the spring motor racks the lens rearward until it is in focus. It's probably nothing that will ever bother you, but you can't take a picture with the object in the center out of focus. There is no way to override the automatic focusing.





IC sensor (left) plugs into Auto-Focus module (below). Its two light - sensitive detectors can be seen in rectangular panel in center of sensor.

The auto-focus carries over into flash. With the Konica's built-in electronic flash up (in shooting position), the camera first focuses, then sets the lens aperture based on point of focus, then checks the focus, then fires. A pointer at the side of the lens, linked to it mechanically, shows if the focusing system is working. At top is a symbol of a mountain (infinity); at bottom, of a head (close-up).

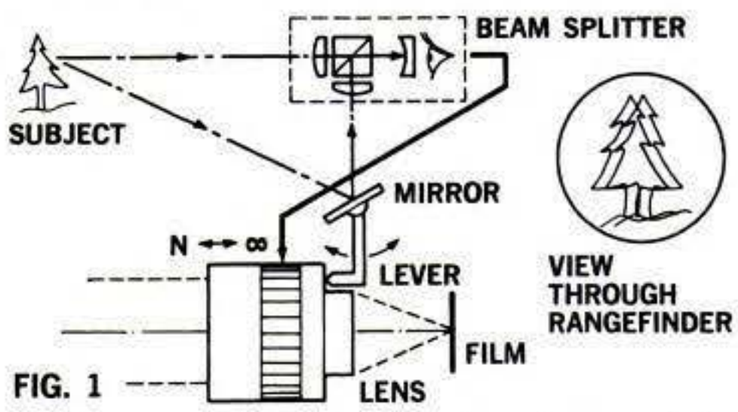


FIG. 1

To see how the Visitronic module does its job, look first at a conventional coincident-image rangefinder (Fig. 1). Its optical system produces two superimposed images of the subject as seen from slightly displaced points (windows in camera). When the mirror (and with it, typically in a modern camera, the lens) has been adjusted so that the two images are exactly superimposed, the lens is in focus.

Now suppose that instead of the elements in Fig. 1's dotted box (beam splitter and eye), you had an integrated circuit (IC) that could sense the matched-image relationship. Fig. 2 shows such an IC, 2.5 mm by 6 mm,

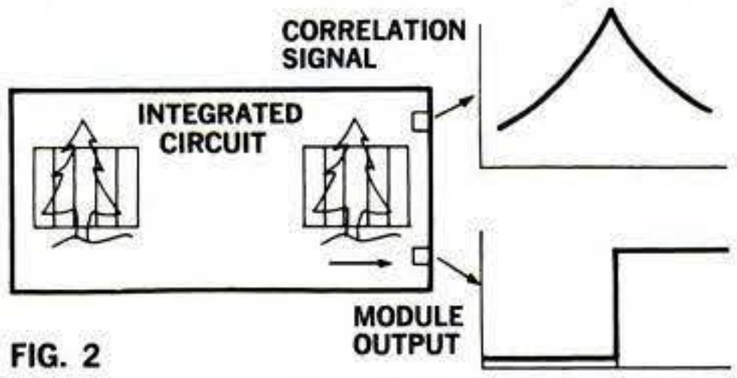


FIG. 2

with two light-sensitive detector areas. The IC compares the images that fall on the two detectors and produces an output voltage, called a correlation signal, that is greatest when the two images are most alike. Thus if one image were to move across the detector area (arrow), a correlation-signal peak would be reached the instant the images were in identical positions. At the same time, the IC would produce a step-function voltage change that, with external control circuitry, would control the position of the lens.

Fig. 3 shows, diagrammatically, the major elements of the Visitronic module: an optical system and the IC. Mirrors—one fixed, one moving—outside the module form the optical base of the rangefinder system. (The farther apart, the more accurate the system.) The prism in the module directs the two images through plastic lenses to the IC's light detectors.

In Fig. 4, we've got it all together: module, mirror system, and subject. The

Continued

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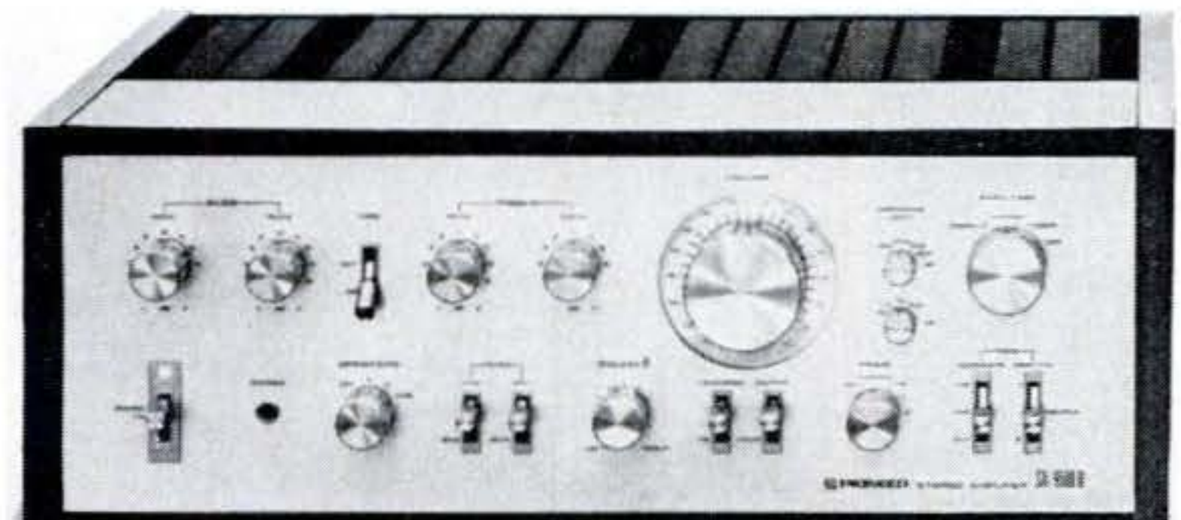

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Its front end features three newly developed field effect transistors that work to let you pull in beautiful FM reception no matter how far you live from the transmitter.

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And where most tuners have multiplex circuits that accidentally cut out some of the frequencies that add depth and presence to the music, the multiplex circuit in the TX 9500II preserves them. So the music begins to sound as if it's coming live from your living room, instead of from some radio station miles away.

Naturally, after developing a tuner this advanced, we had no choice but to create an amplifier that could match it.

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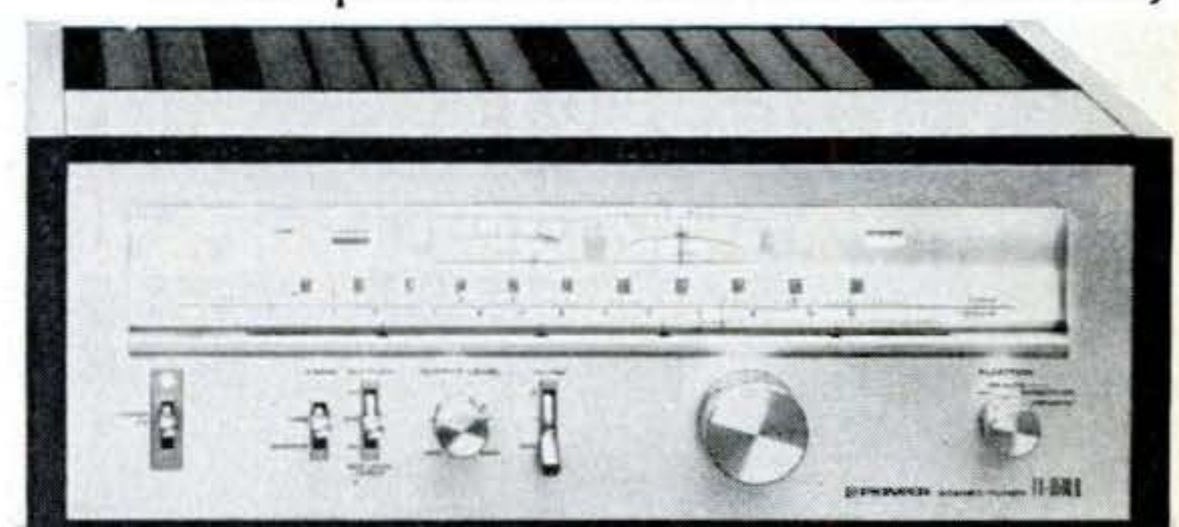

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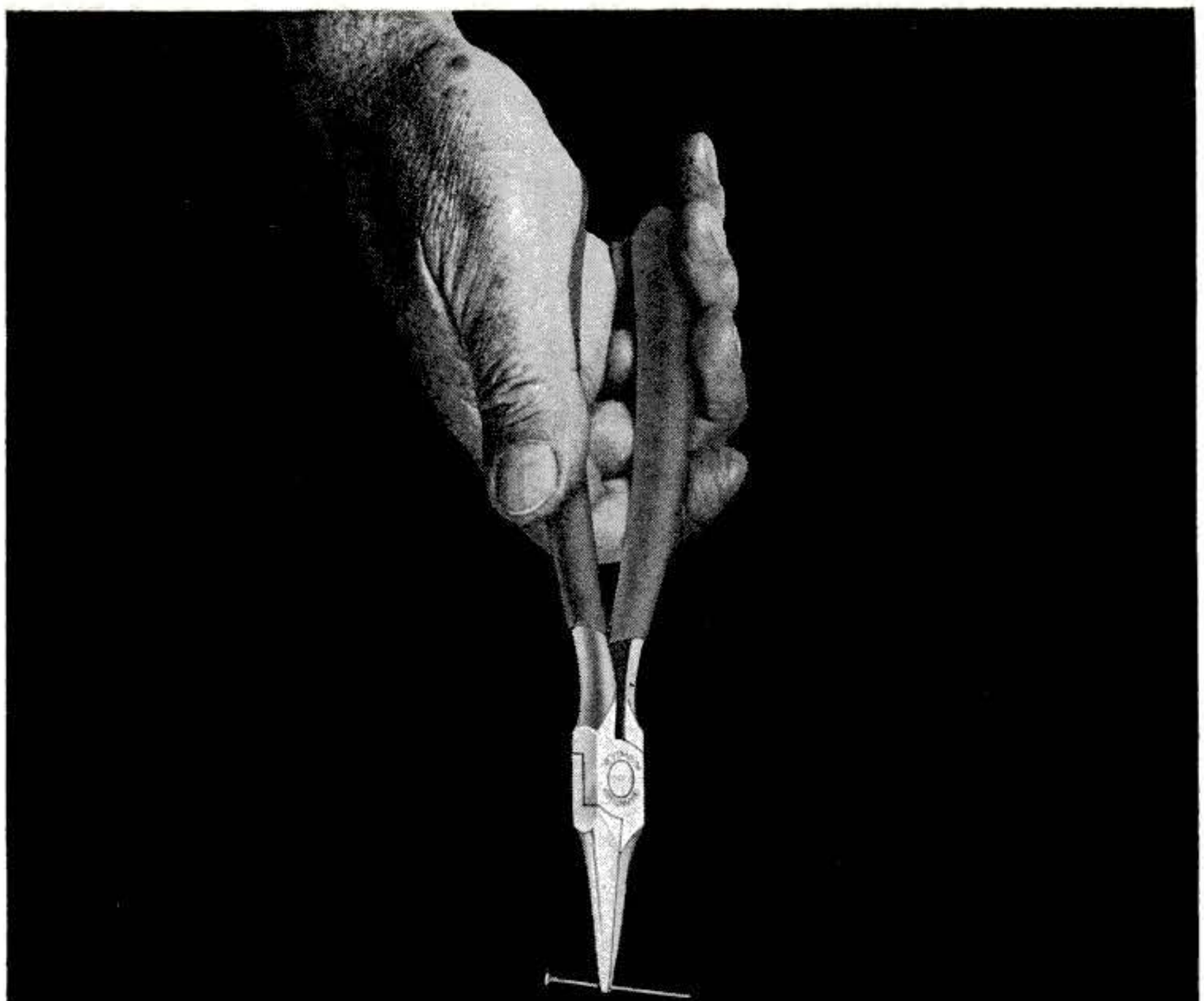

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Through the viewfinder

[*Continued*]

correlation signal shows a complete scan, from infinity to one meter. In the case of multiple peaks, where the IC encounters similarities in brightness patterns, it produces a positive voltage transition for each peak—provided the peak is larger than all previous ones. No transitions occur for later, smaller

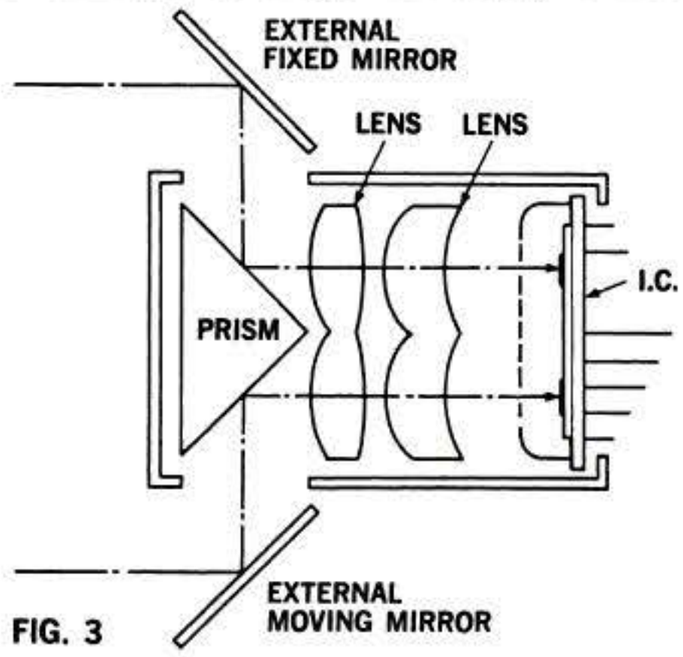

FIG. 3

peaks. The last transition represents the mirror angle corresponding to the largest peak.

The Visitronic system, inventor Norman Stauffer emphasizes, was designed for "optimum performance with

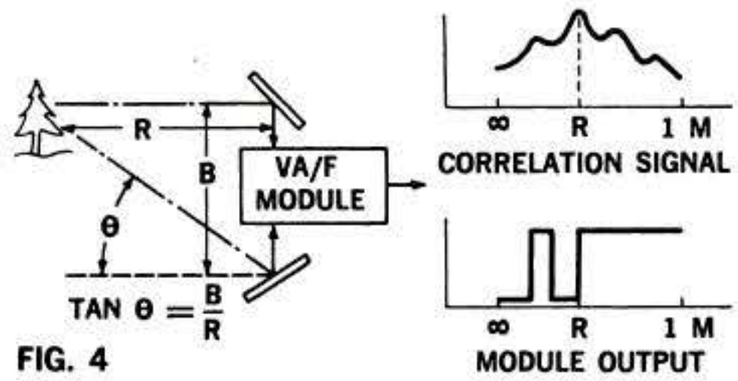

FIG. 4

typical photographic subjects." The system response is greatest for people and faces, the most frequently photographed subjects. But it will work on subjects that would be difficult or impossible for manual focusing—clouds, shadows, and "illumination gradients."

The price for a module is now about $10. Brown expects it to come down, although, he says, it's hard to project prices below $3 without significant advances in technology.

The Konica C35AF, due for introduction late this year or early in 1978, will sell for somewhere under $200. Another camera, a super 8 movie camera, identity still secret, is expected to appear around the same time.

The VA/F system may well find its greatest/value in movie-making, even at the most professional level. Picture yourself panning from a face a few feet away to a mountain miles away with no concern about focusing.

Brown and Stauffer visualize nonphotographic uses for their VA/F system, too. It could, for example, find the range of an object on a conveyor and tell a piece of machinery to do something; or it might, when you were a given distance from a door, tell the door to open.

Before any of those other new uses materialize, however, I'm convinced that the VA/F system will have worked a minor revolution in still photography and a major one in movie photography. PS

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SP4 Mike Lovell, Ft. Riley, Kansas

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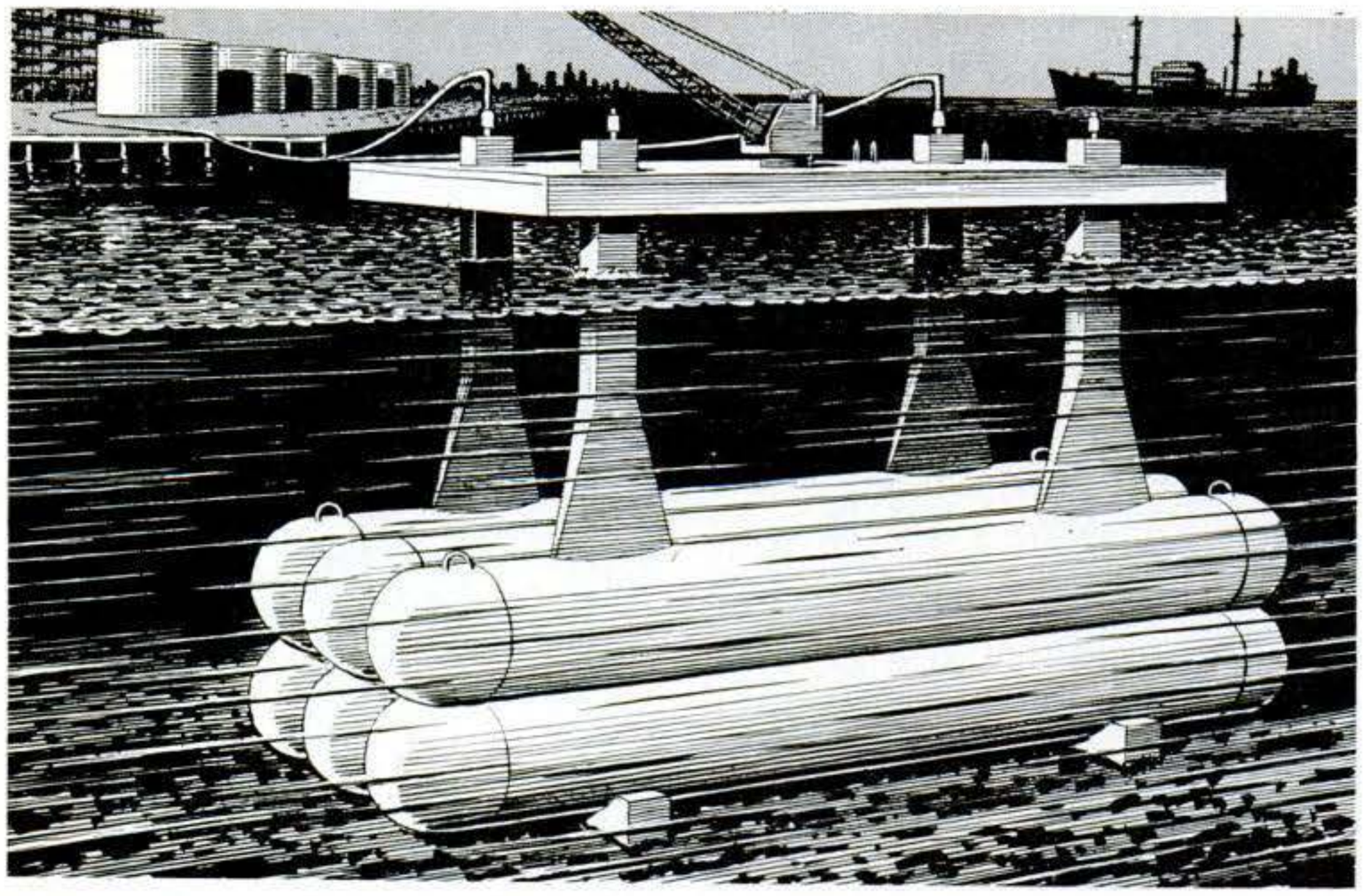
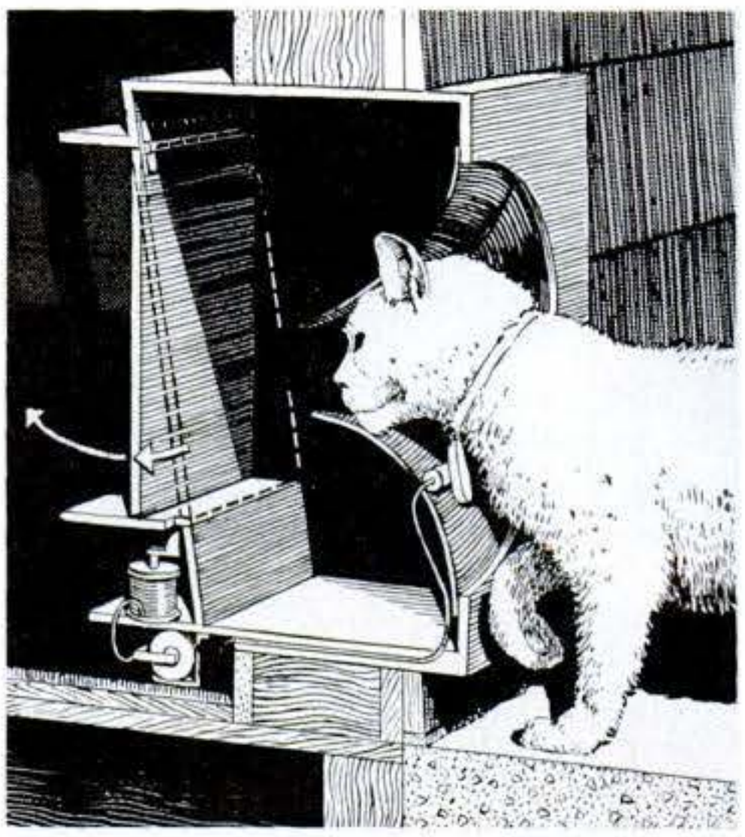
ILLUSTRATIONS BY RAY PIOCH



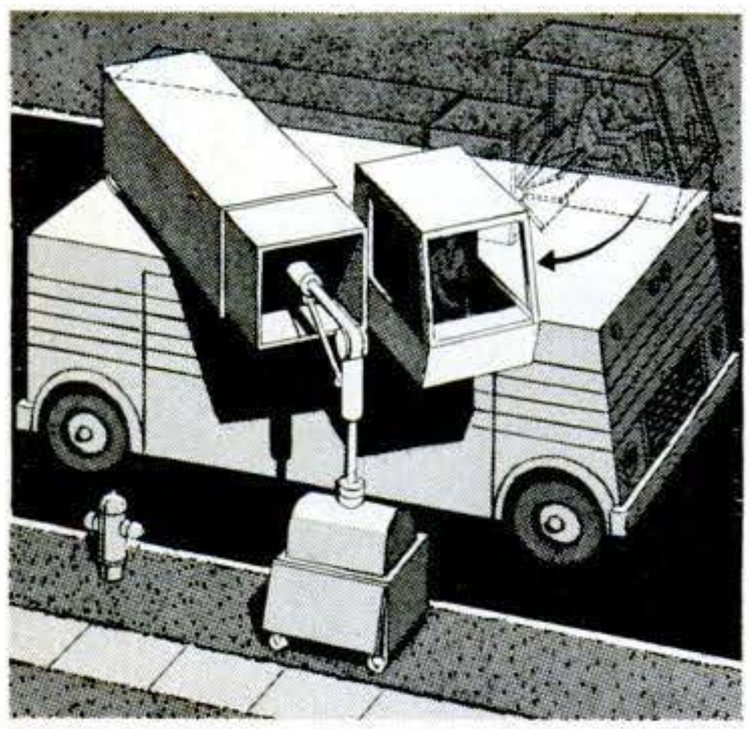
Submerged tanks make oil storage and transport safer

Ballasted to rest securely on a sea bed during loading or unloading, these submerged tanks might simplify offshore transfer and storage of oil and make the job safer. Connected to an above-water deck by slender towers, the vessel would offer little resistance to waves or turbulent seas during oil transfer to or from a tanker or onshore tanks. With air pumped in, the tank could be raised enough to navigate under tow between convenient loading and discharge points.



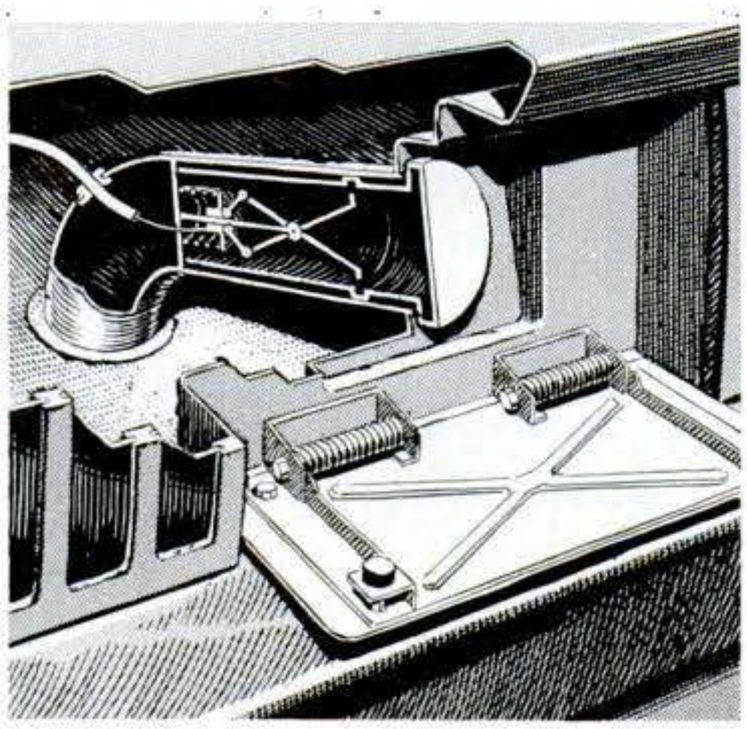
Magnet opens cat door

With a magnet attached to the collar of your cat, you could let it wander in and out at will without worry that it would be followed home by strays. Triggered by your pet's magnetic collar, a reed switch near this weatherproof entrance would trip a solenoid to unlatch a top-hinged door; gravity would slam the door shut behind your pet to keep others from getting inside.



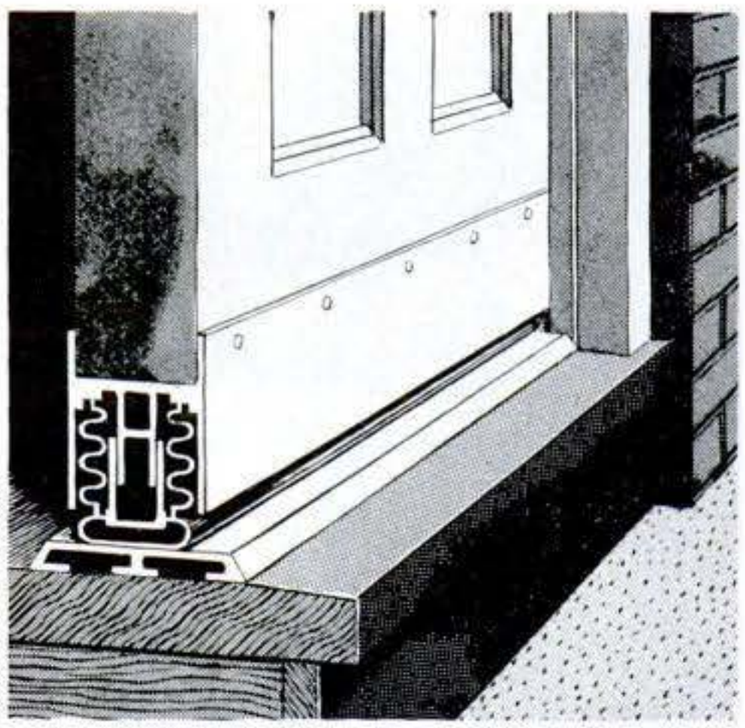
Truck lifts and dumps trash

By swiveling his cab from drive to pick-up positions, one operator on this refuse collector could do the job of a larger team. He'd guide the scoop end of a conveyor into a suitable bin placed at the curb. The refuse would then be carried up and over the vehicle and through a compactor into the truck's storage, dump, and collection chamber.



Dash latch releases gas cap

Extending through the wall of a gas tank, a flexible cable—similar to a camera's shutter release—would let you unlatch two spring-tensioned arms inside the neck of the filler pipe. The dashboard control would keep your gas cap locked until you wanted it released, and would tell you, by feel, when the cap was properly reseated.



Pleated strip seals door

Fitted into a channel at the bottom of a door, this retractable weather strip would adjust itself to floor or sill height, press downward when the door was closed to seal out dust and drafts. Its flexible, accordion-pleated sealing gasket would be extended or retracted by an extruded inner support made up of telescoping, spring-loaded rails.

The following patents have been issued on these inventions: **Submerged tanks**—No. 3,870,003 to Olav Mo, Asker, Norway; **Lift truck**—No. 3,863,787 to H. Ertl, Starnberg, Germany; **Gas-cap latch**—No. 3,868,134 to H. Jorgensen, Toronto, Ontario; **Cat door**—No. 4,022,263 to R. Beckett, San Rafael; M. McBride, San Francisco; and M. Johnson, Santa Clara, Calif.; **Weather seal**—No. 3,871,133 to C. Ellingson, Jr., Burnsville, Minn. Patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

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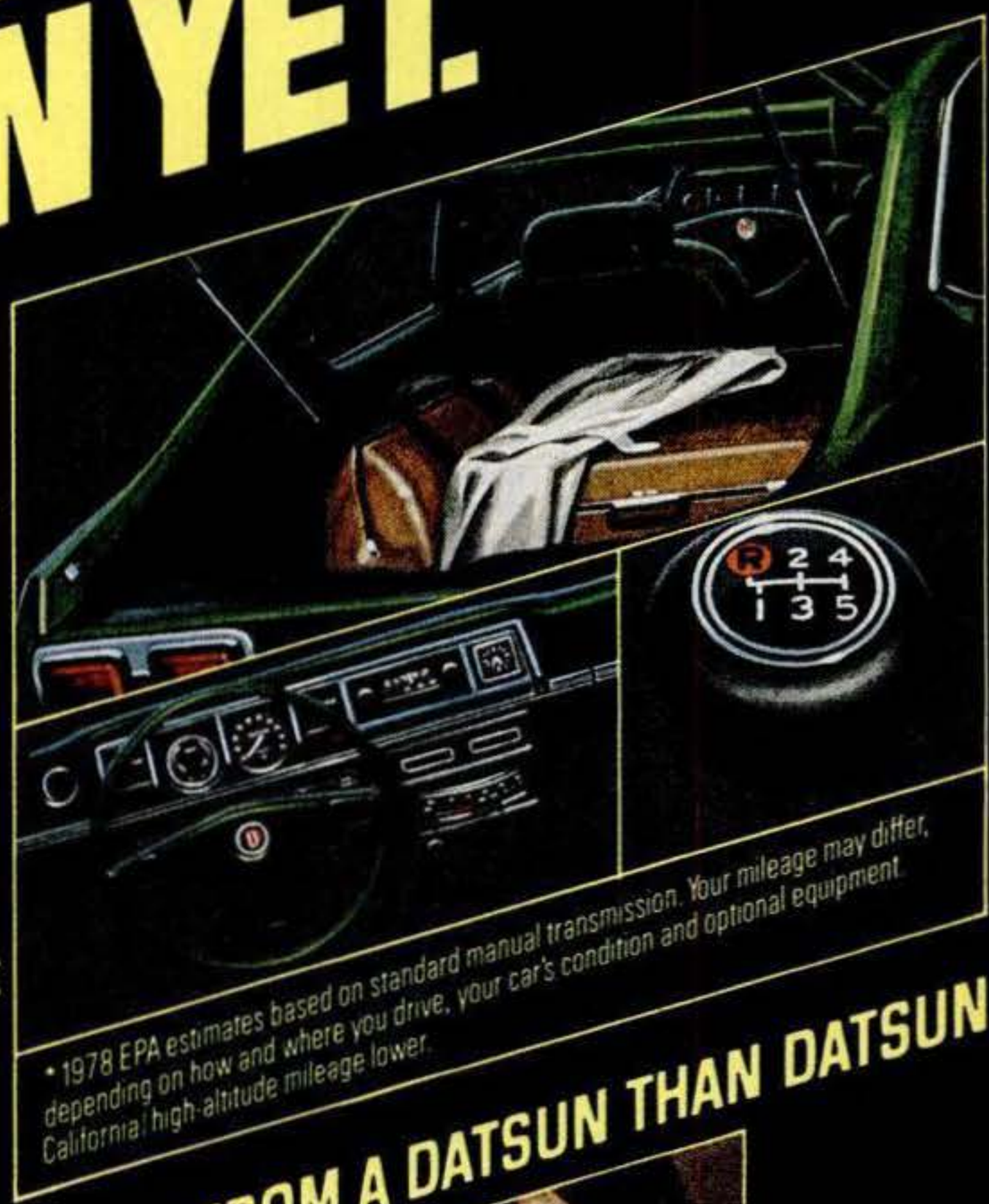

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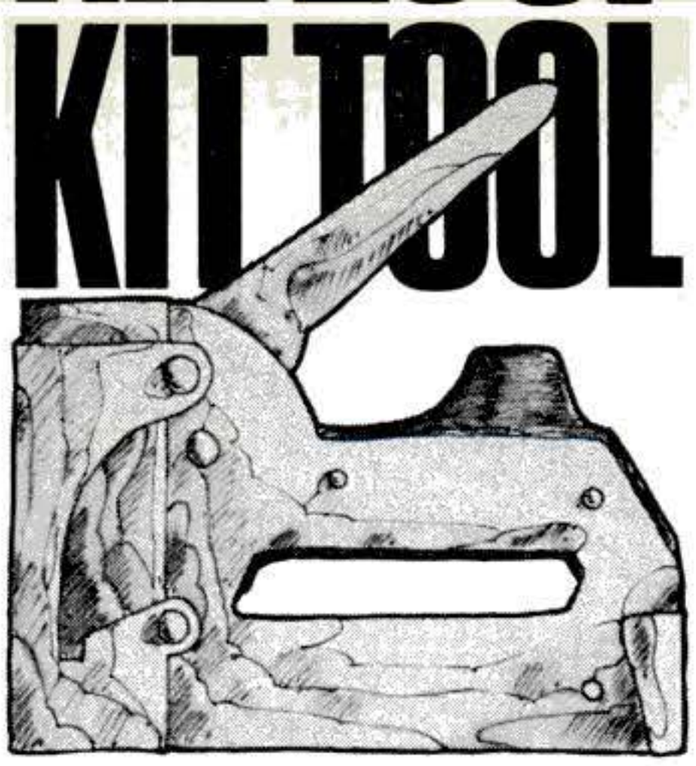

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Wants more mpg

I own a 1976 Ford E-150 van, GVW 6250 lbs., no air-pollution devices, auto trans, six cyl., and 3.00 rear end. I love everything about it except the mpg. At 50 mph and 1600 rpm I get only 15 mpg. The carb is lean, distributor retarded, tires 34 lbs. front and 40 rear, and all economy procedures followed.

What can I do to improve mileage significantly? Should I go for oversize tires to lower the rear-end ratio?

R. A. Wanner, Yorktown, N.Y.

Don't go the oversize-tire route. I'd bet you gain going the other way. That is, change gearing to increase rpm by 400 or so at 50 mph. Then take a look at the power curve of the engine and see where you're at.

Replacing a muffler

I had a replacement muffler installed on my 429-cu.-in. Ford wagon. It's smaller than the original muffler. What effect will this have on engine wear and performance?

George Neuschaefer,
Black Mountain, N.C.

There's no saving in putting on a bargain muffler that runs your engine out of design limits. Maybe you got a deal, but you may be getting ready to buy an unnecessary valve job, too. Original equipment hasn't been too good, I realize. I notice that Dashers, for example, get about 5000 miles to a muffler at a heck of a price.

Stick to a name brand if you don't go back for original equipment. Some of the well-known chain stores are selling undersized junk. Mufflers aren't just silencers—they're more complex.

Sluggish performance

My 1976 LTD Brougham cuts out when I slow down to turn corners or yield. Acceleration is very sluggish. What can I do about it?

Mrs. C. T. Givens, Headland, Ala.

Ma'am, that thing is begging for more fuel at low-end engine speed. What you need to do is play detective in the phone book or ask around and find a shop that understands carburetors and have the carb adjusted for richer off-idle and drive-away.

Synthetic oil good for a diesel?

I am using Mobil 1 in my gasoline-powered automobiles and am very pleased with the product and its performance. Would Mobil 1 be compatible with my 1977 Mercedes-Benz 300D? Due to the car's high purchase price, I wish to minimize risk. The approved list of lubricants published by Mercedes-Benz does not include Mobil 1. I have not read anything on the subject of synthetic motor oils and diesel automobiles.

Burton Baer, Lexington, Ohio

Diesel engines depend considerably on fuel and lubricating-oil compatibility for reliable lubrication and efficient combustion. Don't go for Mobil 1 unless Mobil will recommend it to you in writing.

Should he use racing oil?

I recently purchased a limited-edition 1977 Electra, with a 403-cu.-in. engine and a four-barrel carburetor. I use SAE 10W-20W-30 Quaker State Super Blend motor oil. Because of the unusually high operating temperatures of today's engines, would it be worth the extra money to use Quaker State 10W-20W-30 racing oil?

R. Dennis Gibbs, Richmond, Va.

I doubt it. In use as severe as in racing, it's assumed you have ideal tolerances, carefully controlled warmup, and very short change intervals in terms of time and mileage. This is not the normal schedule or environment for personal-transportation vehicles. It might help a little—as long as you're aware of the differences between the two oils.

Doesn't like handling package

I have a new '77 Chevy Caprice Classic. I believe I made a mistake in getting it with the F 41 handling package (sport suspension) and Firestone GR70 steel-belted radials. I don't like the ride. It's stiff, jolting, and harsh. On all but smooth pavement you are bounced from side to side as if all the shocks are frozen. What is in this suspension package? Can I get rid of the whole thing or at least part of it to make the ride more comfortable?

Michael Chermok, Hopewell, Va.

What makes it stiff is the tires/springs/shocks/sway-bar combination. The heavy-duty suspension kit is very desirable to many performance-minded drivers. But if you don't like it, use your dealer as a middleman to set up a swap with someone who has standard suspension, and each of you can pay your own labor bill.

Noise in the driveline

I have a 1976 Toyota SR5 short-bed pickup with 11,500 miles on it. At 8000 miles it developed a clunk somewhere

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in the driveline and the dealer adjusted the ring-and-pinion backlash. This did not eliminate the noise, and recently a loud and disturbing growl developed somewhere under the truck. It is only evident after the truck has been driven awhile, with the transmission in fourth gear and coasting at about 30 mph. Push in the clutch pedal or apply the gas and the noise disappears. The drive shaft has been replaced and the rear axle wedged to lessen the angle between the drive shaft and the differential. No help. The factory rep says there is nothing wrong with the differential, but I wonder about this since it makes quite a racket when run on the lift. Any ideas? I need help.

John P. Gapcynski,
Yorktown, Va.

Most all axles are noisy when you get your head around them, especially with no load on a lift. That would not be reason enough to get concerned, but once a ring and pinion have been run in a given setting for 1000 miles or more, it's about impossible to change setting without abnormal noise and accelerated wear. Your axle is noisy when coasting? Your clunk, I suspect, is in the transmission tail-shaft drive-shaft slip-yoke area and is the result of spline torque lock. The splines are not free to slide as they should be, so they let go —with a clunk—at higher torque to compensate for length change of the driveline.

Nine times out of 10 the fix here is to replace the ring and pinion.

Wants a diesel transplant

Could you give me advice on installing a Perkins 6-354 diesel in a 1971 International Travelall that has a gas-powered V8 engine with automatic transmission?

J. Nyles Leach, Clifton Springs, N.Y.

The old Travelalls were great pullers, but the last few models were dogs. A diesel would make an older Travelall an even better trailer puller, but there's no way for you to switch one to diesel unless you're rich and stubborn, because it's a whole new engineering deal in weight and gear ratios, and cooling, electrical, and fuel systems.

International now makes a good diesel, but the smallest truck they install it in is not in the personal-transportation category.

For the time being, keep your old Travelall in good shape because I doubt anything better will show up in the next year or two. How do I know so much about International? Guess who's the dealer in Daytona Beach?

Popping muffler

I have a 1968 Chevrolet pickup with a 307 V8 that has developed a muffler "pop" when I am driving at 55-60 mph and then let up on the accelerator suddenly. I've changed the condenser, points, and distributor cap, and checked the coil and wiring. Any suggestions?

Jack Leath, Mansfield, Tex.

Your muffler has some unburned fuel in it, but not enough oxygen to support further combustion. When you let up on the accelerator you go from a positive pressure to subatmospheric. You have an air leak upstream somewhere, and enough fresh air is drawn in to let the hot spot in the muffler ignite the small amount of fuel present.

Synthetic for a bike?

I have a 1974 Harley-Davidson XLCH-1000, with 10:1 TRW pistons. The engine was rebuilt by W&S Engineering. It is stock except for the pistons. W&S recommended I use a 60-weight oil. Can I use a synthetic oil like Mobil 1?

John James Helfrich, Buffalo, N.Y.

No way. Mobil has the protection but would be way short in viscosity. PS

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

Warning:

Any resemblance between most build-it-yourself speakers and hi-fi is purely accidental.

Good sound is no accident. Yet most do-it-yourself speakers and even enclosure plans are based on guesswork, not engineering. That's why most home-brew speakers sound so bad. They're little more than "boom boxes." They are efficient and they play loud, but their frequency response is rough with very little really deep bass.

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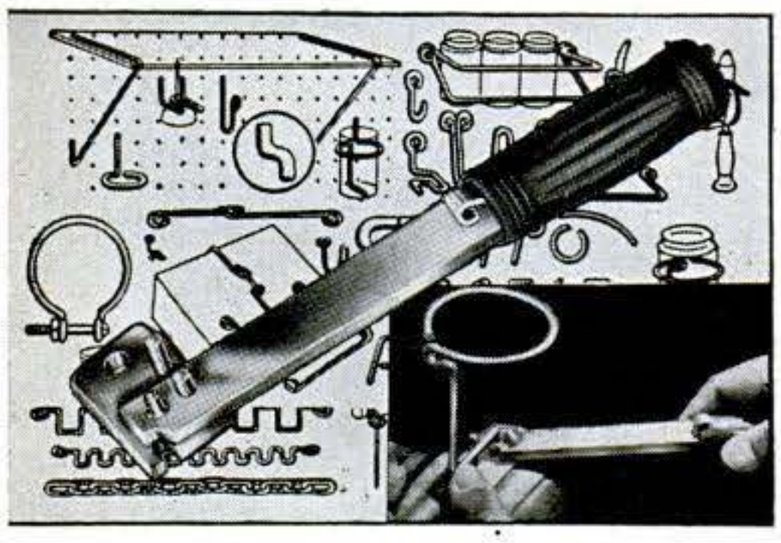

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MOTORCYCLING

BY RAY HILL

Kawasaki KZ650

Last year a new mystery bike was rumored to be coming from Kawasaki: something smaller than a 750, but faster. What arrived was the KZ650, 652cc of high-performance engine patterned after Kawasaki's lengendary KZ1000.

But how good was the KZ650? Could it really beat Suzuki's fast GS750? And how about handling? Big Kawasakis have a reputation for being cantankerous in hard cornering. To get the answers, I rode the new bike 2000 miles in the street, then raced it in a four-hour endurance event.

During the 2000 street miles, the engine always started quickly—although on cooler days it was much more cold-natured than I like, requiring a couple of miles of riding before the choke could be fully released. Power was abundant. But the engine had an annoying stumble when accelerating from idle. Most of it disappeared after a tune-up at 1700 miles—but never completely.

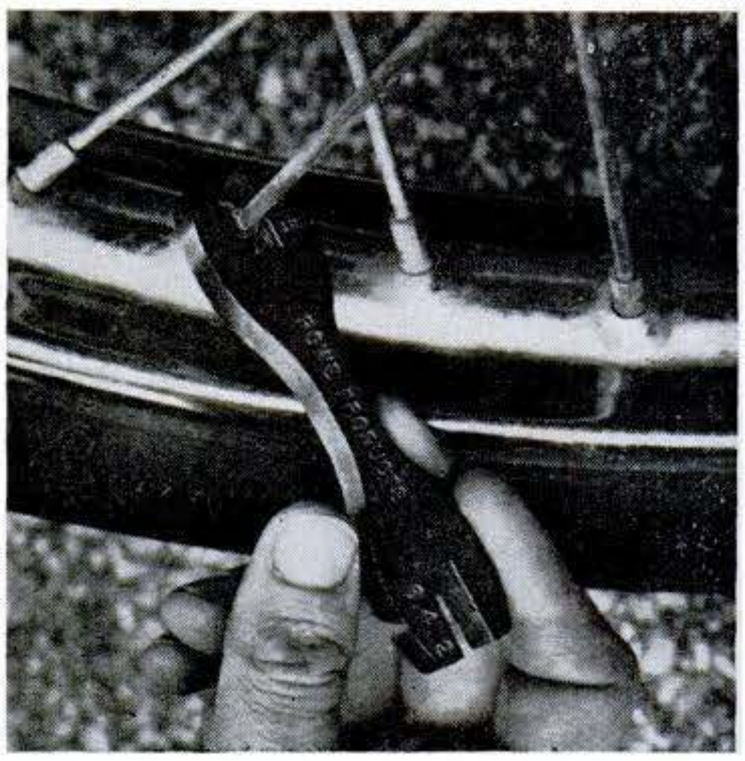
The four-cylinder, four-carb DOHC engine is capable of pulling smoothly around town in high gear at speeds as low as 25 mph. If you're going 50 mph and want to pass a car, you don't need to downshift—just roll on the throttle. Engine and exhaust noise are at quiet levels at all speeds. Mileage was excellent; during several hard road runs I averaged 40.3 mpg.

At the racetrack my partner and I rode the machine to a first-place finish in our class, and fourth overall in a field of 45 bikes. The KZ was able to stay with the GS750 Suzukis in the straights, and actually had more top speed than some bikes over 750cc. The bike's good showing was due primarily to its exceptionally strong engine—and our hard riding in the corners. To give more cornering clearance, we removed the center stand and side stand. But we still scraped the foot pegs and exhaust collectors. Better shocks and heavier fork oil would help. Cornering in the street was no problem, though.

I rate the KZ650 an excellent buy at $1895.

Spoke wrench

Here's a neat little spoke wrench that costs $2.70. Unless you lose it, it'll probably be the last one you'll ever



buy. It fits six different sizes of spoke nipples, and makes turning them an easy job. I tried it on all my motorcycles and several other machines, and one of the six sizes always worked. If your local dealer doesn't stock the wrench, you can order it from Hap Jones Distributing Co., 2 Clinton Park, Box 3068, San Francisco, Calif. 94119.

A couple of pointers: To determine if spokes need tightening, tap each spoke with a screwdriver blade. Each should give out a high-pitched ring. Any flat-sounding spoke should be tightened until it too gives out a high-pitched ring when tapped.

If any spoke nipple requires more than a half turn or so to tighten a spoke, it's not a bad idea to remove the wheel. Then remove the tire, tube, and rim band and make sure the nipple hasn't drawn the end of the spoke up above the nipple flange. If the spoke protrudes above the nipple it may cause a flat tire. Grind, file, or cut away any protruding ends.

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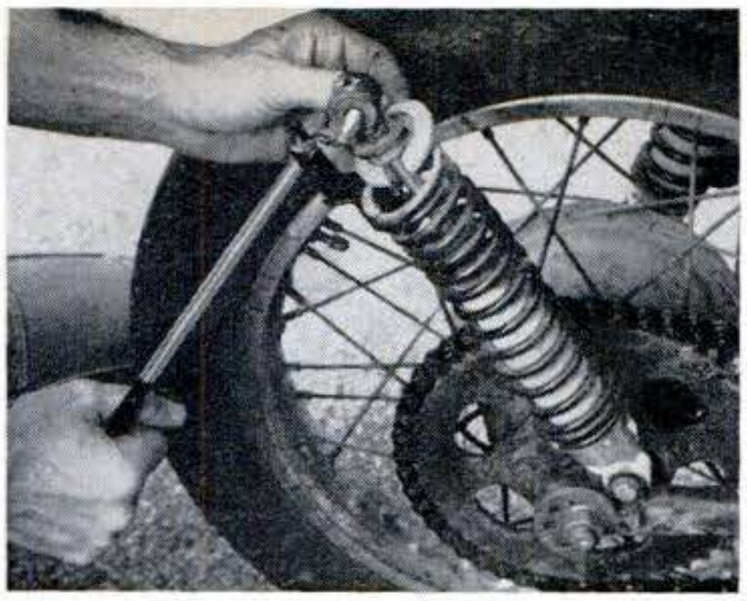


Shock-spring compressor

If you've ever tried replacing your motorcycle's shock springs, you know what a hassle it can be. You have to compress the spring enough so that you can remove the insert at the top of the shock to allow spring removal. Unfortunately you need three hands and a lot of muscle to do this—plus a reserve of patience.

With this spring compressor, the job is an absolute breeze. Just leave one end of the shock on the bike, or place it in a vise, attach the tool as shown, and press down. One man can change shock springs with ease. $7.95 buys the unit from Trancontinental Trade Corp., 155 E. Liberty, Suite A7B, Anaheim, Calif. 92801.

Flexible metric Allen wrenches

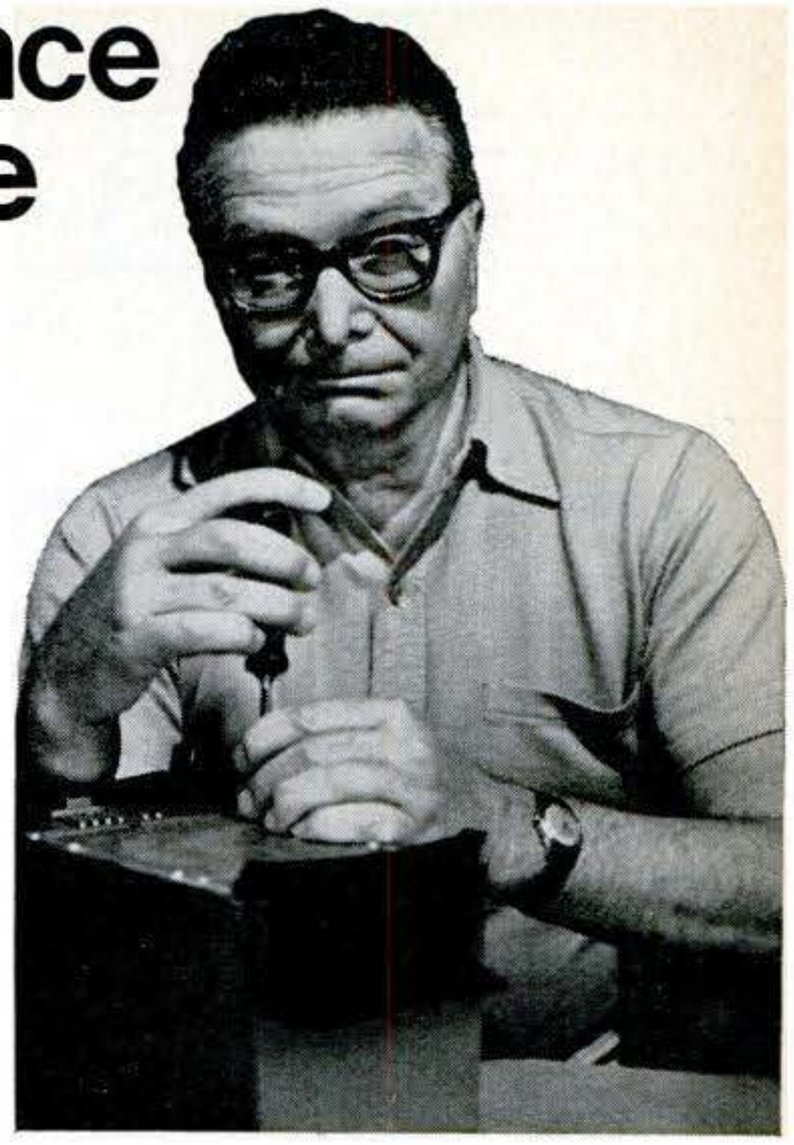
How many times have you used an Allen wrench and wished it were flexible, so you could remove or tighten a bolt faster? Wish no longer. You can buy two of them. One comes with 5mm and 6mm ends, the other with 8mm and 10mm. These four cover most of the Allen sizes you're likely to find.

I've been using these two wrenches for the last couple of months on my machines, and I wouldn't part with them for anything. Not only do they make working with many Allen screws quicker; they are longer than standard wrenches, so you can get more leverage for those super-tight fasteners. The wrenches are sturdily constructed and stand up well to rugged use.

If you can manage the cost, you'll like them. The 5mm/6mm is $10.17, the 8mm/10mm is $11.60. You can order the wrenches from Flanders Co., 340 S. Fair Oaks Ave., Box 2297D, Pasadena, Calif. 91105. PS

HENRY MORGAN SAYS:

"Good appliance repairmen are scarcer than doctors who make house calls."



Did you know that there are over a billion appliances in use in the United States today? And three repairmen. At least that's the way it seems when one of mine goes on the blink. With more than two dozen electrical gadgets in my house going snap, crackle and pop, I finally got tired of trying to locate a guy with enough ambition to take my money and I decided to learn how to make the repairs myself.

When a well-aged comic like me decides to go back to school, you can bet the family jewels it won't be back at P.S. 93. I'm going to learn at home, or not at all. So I sent away for NRI's home study course in Appliance Repair . . . and I took the course.

With a mechanical aptitude slightly below that of King Kong, I needed a course that started at the beginning and didn't move ahead too fast. Well, NRI did just that. They started with electricity—what it is and what it does —and went from there. You proceed at your own rate of speed. Whip through it if you want to, or take your time. What counts is the fact that you learn, in a way that it sticks with you.

You learn two things: how to repair appliances—from little one cylinder gas engines to refrigeration and air conditioning equipment; and how to get started in your own appliance business. That can mean money for you either way. If NRI can turn old ten thumbs Morgan into a reasonable facsimile of a repairman, think what they could do for you!

NRI's no fly-by-night outfit. They've been training men for more than sixty years . . . and they've had over a million students. It's the oldest and largest home study school in the field of electronics and electricity, so they know it better than anyone else around.

The NRI course is really easy to understand . . . with lots of pictures to show you what they're talking about. They even send you a professional appliance tester at no extra cost.

With the tester and a few basic tools you probably have already, you're ready to service most electrical appliances. After a few months, you'll be fixing your own appliances like I do, or you can start earning spare time money fixing them for your friends and neighbors. Before you know it, you can have your own full-time business and be independent.

Take my advice and clip the coupon. Even if you don't know which end of a screwdriver is the handle, they can give you real professional training that'll help you break into the appliance repair field. It's one of the few things I've ever sent for that was even better than they said it would be . . . so why not invest a postage stamp to see if it's right for you. The NRI catalog is free and there's no obligation. No one will knock at your door or bug you at home. NRI doesn't use salesmen. They don't need them.

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DETROIT REPORT

By JIM DUNNE

Rotary rumors

The small cars GM has planned for 1979 and the future seem ideal for rotary-engine use. A small group of GM executives thinks that the rotary's smoothness, small size, and power are a perfect match for cars now on the planning boards, because the old bugaboo of fuel economy is no longer a worry. (Mazda gets about 30+ mpg/highway from its rotary cars.) The advances Mazda has made with the newest Cosmo rotary have GM engineers salivating, and that has given a big boost to interest in the rotary. Two GM divisions, reportedly Cadillac and Chevrolet, are interested enough to make formal proposals for management approval. Best bets for first installation: Corvette and Seville. But even if an okay were forthcoming, production couldn't begin before 1980.

New full-size Plymouth and Dodge

Next year Chrysler will introduce a new line of full-size Plymouths and Dodges (which were dropped at the end of the 1977 model run). The new cars will be quite a bit smaller, lighter, and more fuel-efficient, but they'll offer about the same amount of passenger space as the old models. The 1979 Plymouth Gran Fury and Dodge Royal Monaco will have a wheelbase half a foot shorter (116 in.) and will be up to a foot shorter overall. They'll feature an industry first: fabricated aluminum wheels. When the new full-size cars come out, the intermediates will be dropped from the lineup. They're too much alike in size and features to compete.

Favorite colors

Light shades of metallic blue and of silver were the most popular colors with Chevy buyers this past year. For Corvette buyers, white remains number one. Just a few years ago green was a top choice. The industry also went through an earth-color phase recently when reds, browns, and greens were the top choices. Two-tone colors are making a slight comeback, especially the slightly contrasting tone-on-tone motif—a solid color matched with a metallic of the same shade.

Developmental delays

Problems with GM's new front-drive chassis for its X-body line (Nova, Phoenix, etc.) have caused delays. GM is now shooting for 1979½ introduction, a half year later than first planned. Development of new transmissions, a new suspension system, and new engines for the totally new design have just gone slower than expected.

Air-bag alternatives

Federal law calls for "passive restraints," but not specifically for air bags, in 1982 model cars. That means only that the driver and passengers should not have to do anything (like buckling a belt) to put the system in operation. Automatic seat-belt systems, like VW's, look like an attractive alternative. They are cheaper, simpler, easier to develop, and possibly more reliable in the long run. GM will offer automatic belts as an option on a number of cars by the start of the 1979 model year. Air bags will be ready on an optional basis by 1981.

FWD Fords

Ford will follow GM and Chrysler in bringing out a front-wheel-drive line of cars for American production. The company plans to have a front-drive, mid-size line by 1981, three years after the debut of the Plymouth Horizon and two years after the GM X-car line appears. Ford will use a four-speed-automatic overdrive transmission with front drive, and V8's as well as six-cylinder FWD cars may be built. Up to now, Ford has resisted front drive for its domestic cars because, it claims, the design costs "$50 to $100 more" than the conventional rear-wheel design.

More electronics

It would have happened anyway, but the demands of fuel economy, emissions control, and maintenance reduction have accelerated the use of electronic controls in automobiles. Once you have a computer on board, the tendency to find new jobs for it is apparently irresistible. Chrysler estimates that by 1985, 10 percent of the cost of a car will be for electronics. Eventually, computers will control carburetors, transmissions, brakes, and instrument panels. On-board diagnostic systems are already a reality, and electronics will also help reduce maintenance by replacing mechanical systems with electronic ones. The electronic distributor is one example of this trend. The big appeal of electronic parts lies in their small size, light weight, speed, and precision.

Trimmer Vette

By 1980, Chevrolet plans to cut the weight of the Corvette by 400 pounds —more than eight percent. Biggest cuts will be made in plastic body parts, where a new molding process will allow more glass reinforcement in thinner plastic sections. Also, flanges and ribs will be formed into the plastic, not added on at a later time. The spare wheel and possibly the running wheels are scheduled for plastic or aluminum. In 1979, the Corvette will be equipped with a new type of plastic shell seat covered with foam cushioning, which replaces the steel-frame-and-spring type now used for a saving of 25 pounds. Result of the 400-pound weight reduction is a one-mpg improvement in the Corvette's fuel economy.

Chrysler's new four

Chrysler will probably build its own four-cylinder engine in 1980; it could be used in compact and smaller Plymouth and Dodge cars. Until then, Chrysler will buy at least 300,000 four-cylinder engines from VW for installation in the subcompact Horizons and Omnis. But the Chrysler-made four, now being planned, could replace that engine. A 2.2-liter size is planned to begin with. Later, a 1.7-liter displacement may be added.

Clearly better

Ford claims that the reductions made in glass thickness in the Fairmont/Zephyr have reduced the weight of glass in these cars even though more glass surface is provided. The cars have 5/32-inch-thick glass instead of the 7/32-inch glass in other Ford products, for weight savings of 12 to 13 pounds per car. The thinner glass must pass the same strength tests as the older glass. Eventually, thin glass will be used in all Ford vehicles, the changeover being made gradually as each model line is restyled. Added strength of the thinner glass is a Ford development that results from a faster cool-down in the tempering process.

Chevrolet's 60° V6

Chevy will build a 60° V6 for the 1979½ Nova. The new engine is specially designed for the front-wheel-drive system slated for the new compacts. Its narrower V-angle (the current V6 has a 90° V) will permit Chevy to fit the engine under the hood in a transverse position, and still leave room for accessories. Present plans call for a 2.7-liter displacement, but the engine could be enlarged to 3.3 liters if a more powerful version is needed. The compact's engine and drive train may find their way into the new generation of Camaros and Firebirds—if the design delivers the handling characteristics the engineers want. The jury is still out. PS

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Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

Color Story. When a motor oil turns black after driving, does this mean that it is due for a change?

C.H.S., Parma, Ohio

When an oil turns black, it indicates that the detergent dispersant action of the oil is doing the job for which it is intended. That job is to maintain combustion products and foreign particles harmlessly in suspension until they can be drained away at the next oil change. It does not necessarily indicate the need for an oil change.

Few and Far Between. I own a 1976 Oldsmobile 98, which I drive only once a week between 15 and 25 miles. Do you think it's a good idea to start the car every day to keep the oil circulating? Also, considering the limited use of this car, what oil drain intervals do you recommend?

R.K., Chicago, Illinois

Under no circumstances should you start the engine every day merely to circulate the oil. Such a practice could increase contamination of the crankcase oil and promote rust and corrosion of bearing surfaces inside the engine. Driving very short distances once a week warrants an oil change at least every three months using a conventional SE motor oil. If you're using Pennzoil P·Z·L Extended Life Motor Oil, annual changes should be sufficient.

Multi-Vis Makes Sense. I recently bought a 1974 Chevrolet van with a 350 V-8 engine. Since the previous owner used Pennzoil 10W-40, will switching to a single grade of Pennzoil cause any engine problems?

M.S., Kellogg, Idaho

Changing to a single grade oil will not harm the engine, but you would have to use different grades depending on weather conditions. Your van would probably require an SAE 10W or 20W during the winter, and SAE 40 during the summer for maximum engine protection. We recommend that you continue to use Pennzoil 10W-40. The use of 10W-40 eliminates these change-overs, and will give your engine protection over the wide range of temperatures in your area throughout the entire year.

P·Z·L for "Z". I drive a 1976 Datsun 280Z, and presently use Pennzoil SAE 10W-40. I do a lot of around town, stop-and-go driving, and have been considering switching to Pennzoil P·Z·L. Recently a mechanic advised me to use Pennzoil Racing Oil. What do you suggest?

A.G.P., Los Angeles, California

The selection of the proper type and SAE grade of oil is dependent to a great extent on driving conditions. For the conditions you described, we recommend P·Z·L for your Datsun 280Z engine. The oil is a combination of mineral oil with synthetic, along with detergents, dispersants and other additives to provide maximum engine protection. It will give you the fast flow properties of SAE 10W on cool mornings and at start-up, and the protection of SAE 50 when hot.

Lathe Lubrication. I recently acquired a 1941 10″ metal working lathe. The owner's manual recommends 10W motor oil for lubrication of the gear box and other parts. Can I use Pennzoil SAE 10W-40 instead, since I use that in my car? Is there any truth to the statement that detergent motor oil is not a suitable light machine oil?

G.F., Newport News, Virginia

We recommend you use SAE 10W for your lathe, as the owner's manual suggests. The viscosity of SAE 10W-40 is too high for the temperatures at which your lathe operates and could result in excessive heat build-up. It is true that in certain applications a detergent motor oil is not a suitable light machine oil, especially in cases where high heat is involved. In your lathe, however, Pennzoil Z-7 SAE 10W would be satisfactory.

Power Failure. I drive a 1969 Buick with 125,000 miles, and have always changed my oil and oil filter every 3,000 miles. Lately when I start my car in the cold morning, it seems like I don't have power steering for a few minutes. One mechanic told me to drain the power steering fluid and refill with fresh. Can the fluid in the power steering well become contaminated? Another mechanic said that the problem may be my power steering pump. Who is right?

E.A., Fresh Meadows, N.Y.

In this case both mechanics could be correct. Your power steering fluid may be contaminated to the point where it does not readily flow when cold, or your power steering pump may be showing signs of wear.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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ADVENTURES IN ALTERNATE ENERGY

A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Ronald W. Kock: Tubular collector in a drain-down system

By EDWARD MORAN

Ron Kock's solar water-heating system combines an innovative concentrating-collector design with a drain-down feature that eliminates the need for a heat exchanger. At night or on cloudy days, when solar radiation is lacking, water drains by gravity from rooftop to storage tank. The system, built two years ago, cost Kock about $330 complete. Several modifications have since been made to the original design.

The solar preheater (see upper drawing, below) consists of a 25-gallon tank (rated at 150 psi) placed adjacent to a standard gas-fired water heater; a roof-mounted tubular collector array; 80 feet of ½-in. PVC piping; and a 210-watt centrifugal pump capable of lifting two gpm of water against 20 feet of head from tank to collectors.

Using a bypass valve, Kock connected the two tanks in series. Cold water can be delivered at 50 psi either to the top of the water heater or to the bottom of the preheater tank. Water from the preheater is

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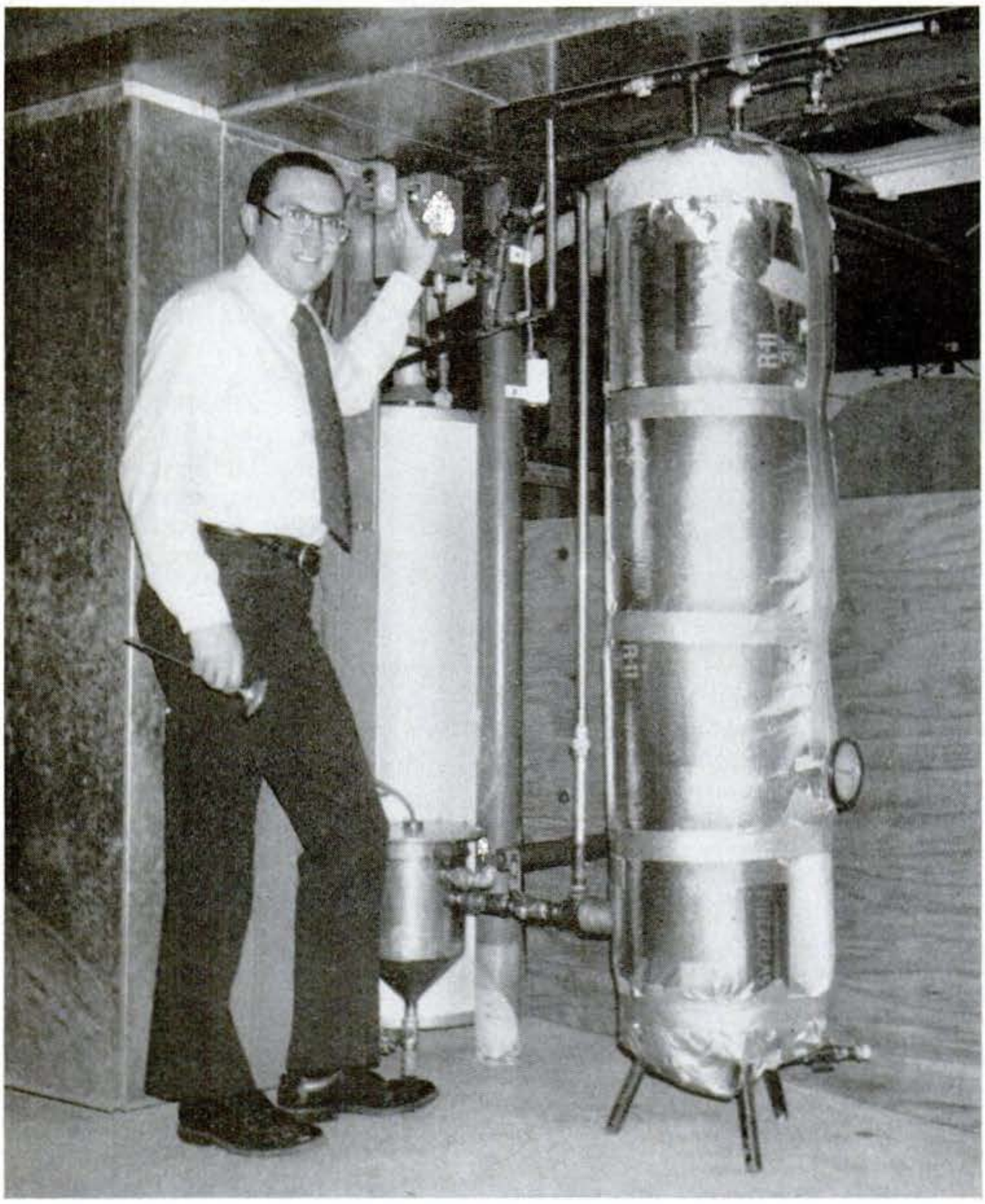
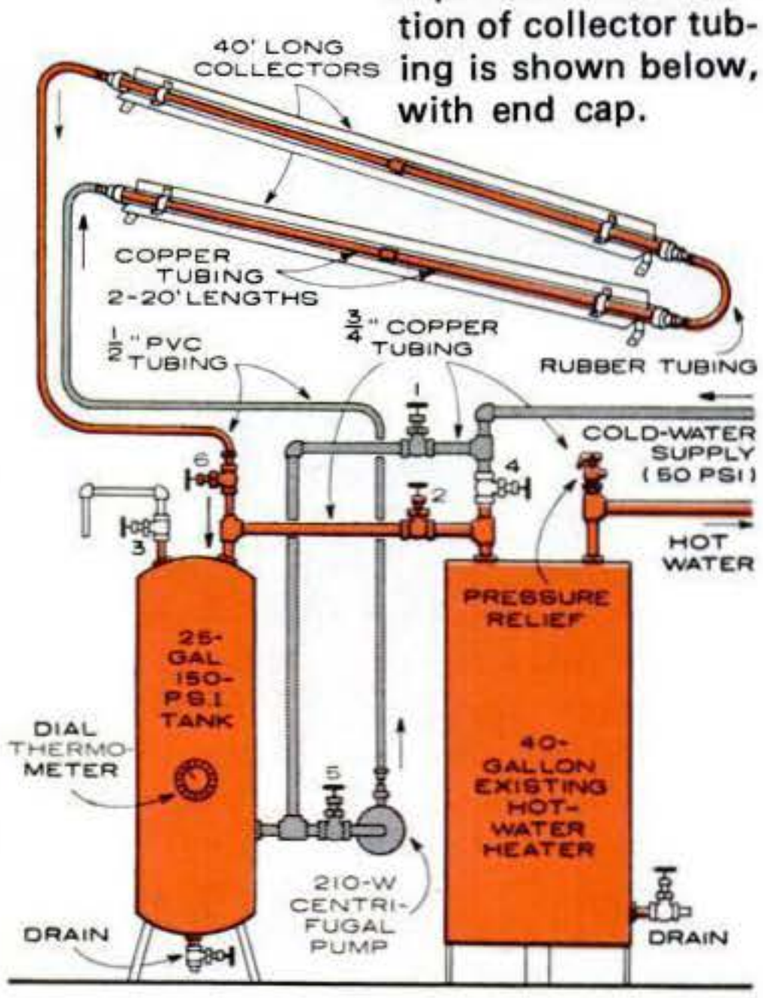
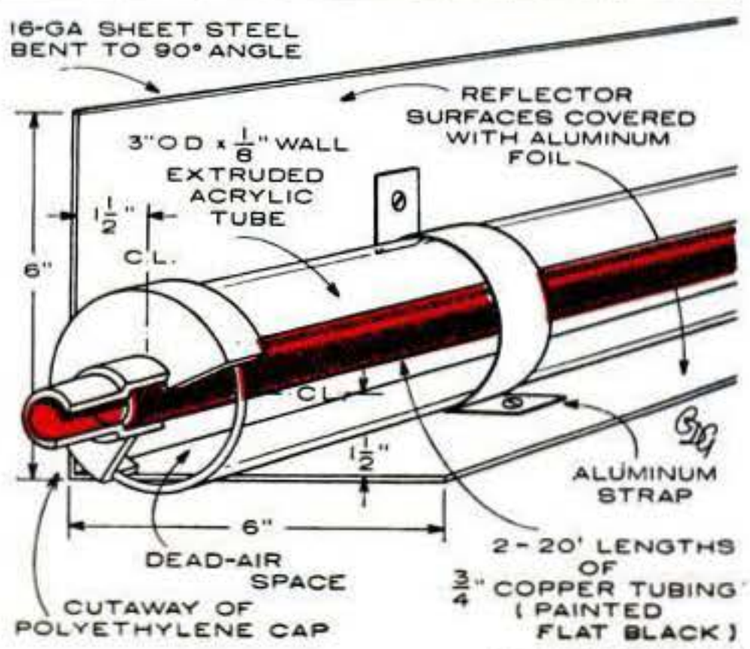
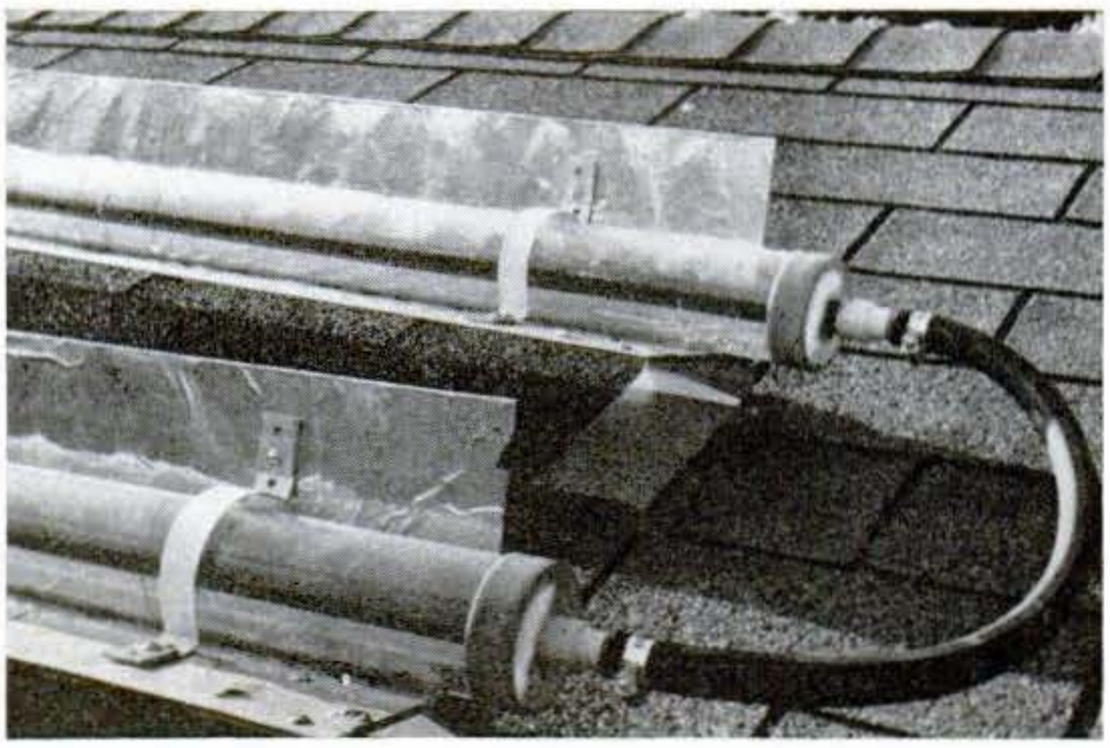


System diagram indicates positioning of valves, which can be manually adjusted to isolate solar loop from conventional system as required. Cross-section of collector tubing is shown below, with end cap.







Valving his solar preheater, Ron Kock demonstrates practicality of a drain-down system. Preheater tank (above, right) holds 25 gallons, has foil-backed insulation. Tubular collector (photo at right) is acrylic-encased copper tubing strapped in a reflector trough. Tubing is tilted downward to aid gravity drain-down.

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Give Windsor. It's got a reputation for smoothness.

[*Continued*]

drawn into the larger water heater upon demand.

Whenever Kock wants to solar-heat the water in the preheater tank, he valves off the water heater and cold supply lines, and relieves the preheater tank pressure through the overflow valve. He then opens both the collector and pump valves, and actuates the pump to circulate cold water from the preheater tank. Once this water is warm enough, the pump is stopped, and water in collector and piping drains down by gravity into the preheater tank. The warmed water will have expanded, and any excess is discharged through the overflow valve.

Kock's concentrating collector consists of four 20-ft.-long strips of ¾-in. copper tubes painted black for greater absorbency of sunlight. As shown in the drawing, the collector configuration is V-shaped, with each leg roughly 40 feet long (two 20-ft. copper strips in each leg). Rubber tubing (see photo) connects the two legs at one end.

The copper tubes are centered within three six-ft. lengths of 3-in.-o.d. clear acrylic tubing (see cross-section drawing), and are supported by polyethylene caps at the ends of the acrylic tubes. (The caps also seal out moisture, which can condense and fog the acrylic.)

To enhance the intensity of sunlight focused on the absorber tubing, Kock mounted the rooftop piping over two reflector troughs, which he created by bending 16-ga. sheet steel to a 90° angle. The acrylic tubing is attached to the troughs with aluminum straps.

Tubular collectors

Kock believes this collector has several advantages over typical flat-plate collectors. For one thing, it's easier to build, he says. "Thermal-expansion differences between glazing and support frame are not a problem, as with flat-plate collectors, because the tubular glazing is merely strapped to the support." No insulation is required between absorber (copper tubes) and support frame since the tubular absorber is suspended in air.

Structural integrity is also better, he claims: Cylindrical glazing allows for thinner cross-sections to be used, improving transmission of radiation. And the acrylic tubing is more impact-resistant than a flat section. Also, tubular collector surfaces remain perpendicular to the sun as it moves through its elevation angle, while the flat-plate collector must be tilted to a compromise angle.

But Kock admits there are disadvantages, too. He agrees that the expensive acrylic tubing does not weather very well, and the design takes up more roof space than more compact flat-plate devices. (He'll experiment with the latter type before drawing final conclusions.)

A timer and photocell, mounted in a south window, permit circulation of water only under optimum solar conditions—not at night or on cloudy days, or when the delta-T is inappropriate, for example.

Performance data

Kock has been collecting test data on his system and supports his efficiency claims with Btu figures. On a clear day last February, when ambient temperatures ranged from 40° to 55° F, the collectors absorbed 12,392 Btu out of a total of 23,250 available, for an overall efficiency of 53 percent. Heat from the pump provided 3500 Btu.

But all is not sunny, and Kock makes no pretense about the negligible dollars-and-cents savings of the system. The economics look better when compared with costs of running an electric water heater, however. Indeed, Ron Kock is rather candid about his mishaps. "I am enclosing the black-and-white glossy photos you requested," he wrote me in February. "Unfortunately, the collector has been covered with snow since the first of this year . . . Could you use a 35mm slide taken last summer?"

But Kock admits that the system is experimental and that he's always making changes to eliminate any problems.

To ask a specific question, send a stamped return envelope to Ronald W. Kock, 1854 Greenpine Drive, Cincinnati, Ohio 45231. PS

Your idea may bring you $200

Each month, we'll present a project developed by a PS reader and pay the inventor $200. Ideas not suitable for this series might be purchased at regular rates for use elsewhere in the magazine.

To enter, send us black-and-white glossies (one photo should show you demonstrating your device) plus pertinent text and sketches. Write your name, address, and Social Security number on each item. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers, if it's accompanied by a stamped envelope.

Mail entries to Energy Adventure, Popular Science, 380 Madison Ave., N.Y., N.Y. 10017.

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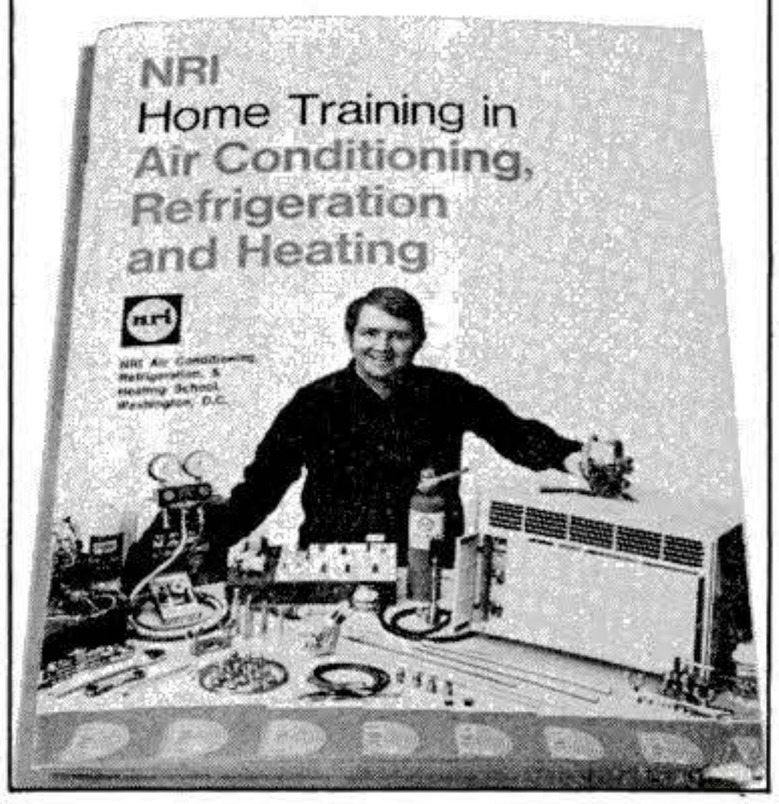

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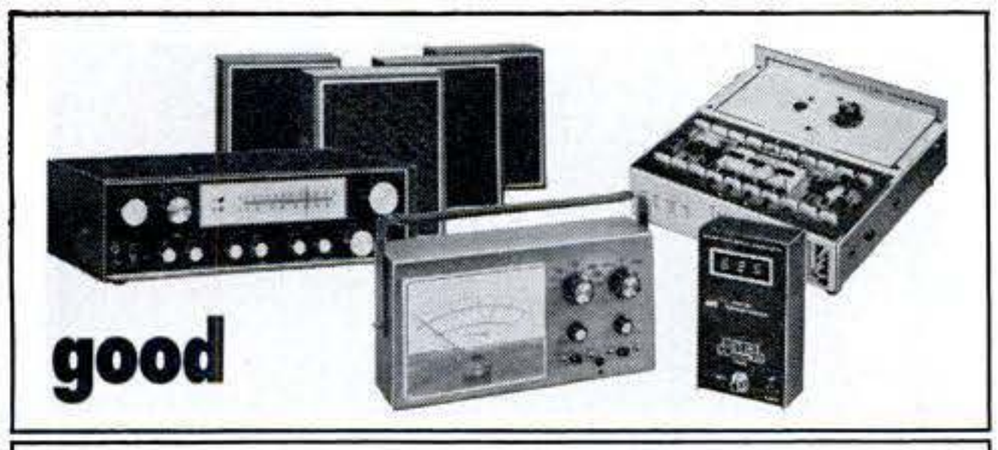

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14 kits with 25″ diagonal color TV and Quadraphonic Stereo...$1195 or low monthly terms

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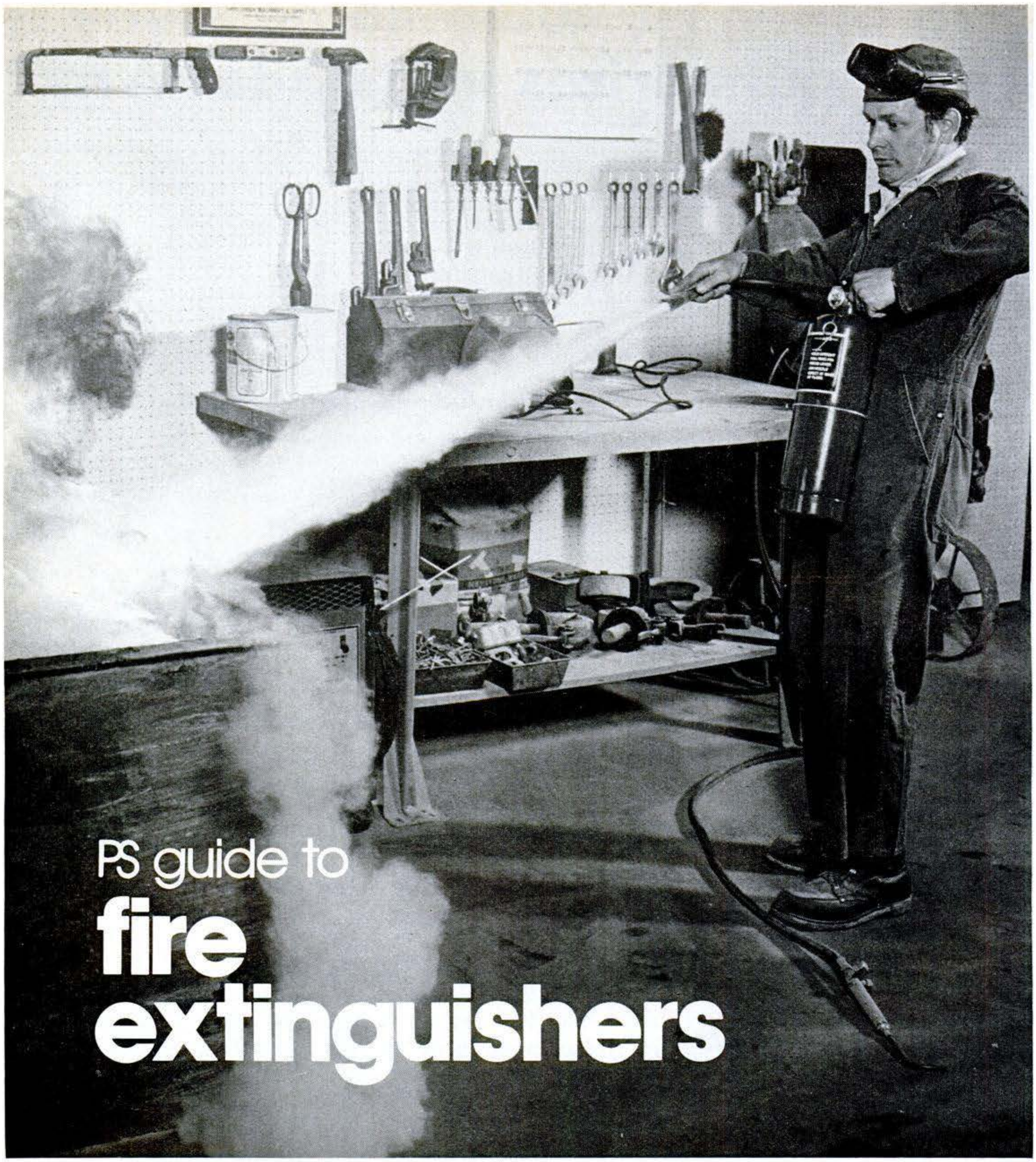

PS guide to

fire extinguishers

An extinguisher douses a confined fire in a waste-bin. Never tackle more than you—or the extinguisher—can handle.

What ingredients? What type? What rating? How heavy? Knowing the answers could prevent disaster

By CHARLES SALIT

Choosing a home fire extinguisher used to be as simple as reading the ABC code on the label. Extinguishers came in one color—fire-engine red; in one size range—big and bulky; and in two main types—water and soda-acid. But most were so costly that many families didn't bother to buy one.

Today, fire extinguishers are more affordable, but choosing one is more difficult. Many extinguishers list unfamiliar ingredients such as Halon 1211, or "dry chemical." Weights range from small, three-pound decorator-designed models up to hefty 39-pounders. Prices start at about $14 and go up as high as $208 (see table). And the familiar ABC classification has mutated into confusing codes such as "1-A:10-B:C."

How to choose

The first step is to identify potential fire hazards. On your sailboat, you may be most worried about Class A fires from ordinary combustibles such as wood or cloth. In your car, you need protection against Class B fires of flammable liquids such as gas and oil. At

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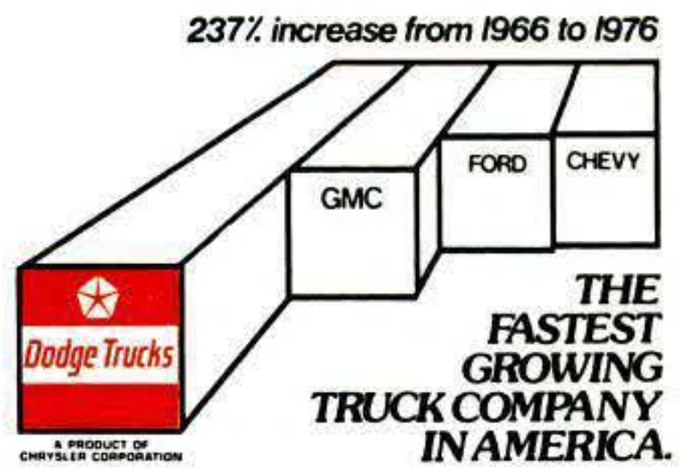

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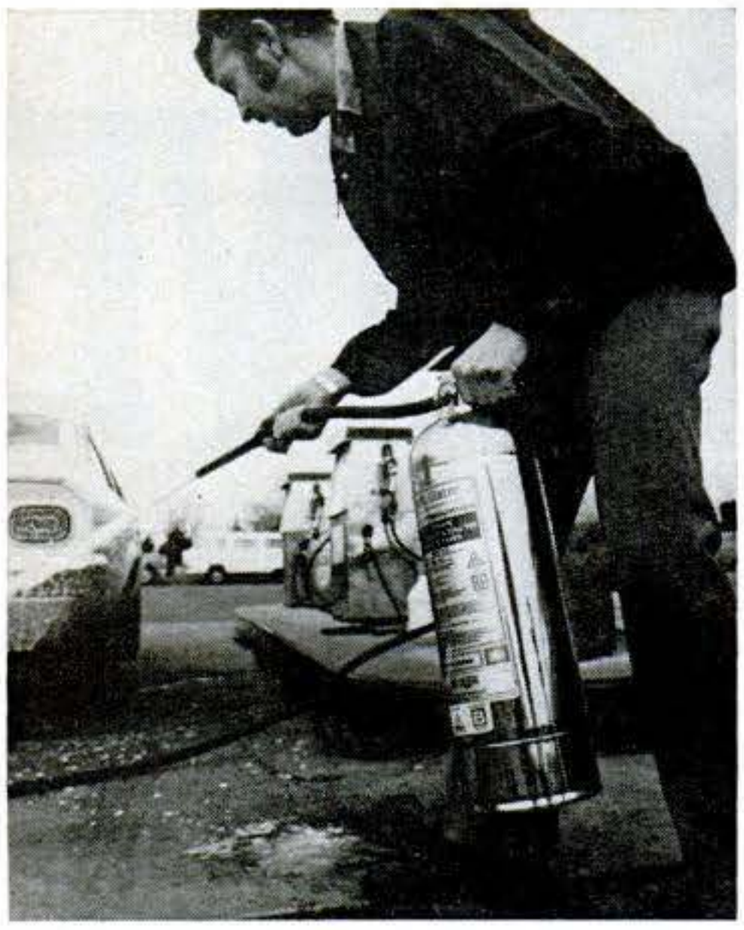

Chemical concentrate in 3M's "Light Water" extinguisher makes it effective against flaming gasoline or oil.

Buyer's guide

Model	Type	UL Rating	Capacity (lbs.)	Weight (lbs.)	Price
AMEREX CORP., Box 81, Trussville, Ala. 35173					
417	MP	1-A:10-B:C	2½	5¼	$ 23
425	MP	2-A:10-B:C	4¾	9	34
424	MP	2-A:10-B:C	4¾	9½	41
419	MP	4-A:60-B:C	10	19	54
426	MP	4-A:60-B:C	10	16	50
421	MP	4-A:60-B:C	10	19	54
361	H	2-A:60-B:C	17	39	208
352	H	5-B:C	2½	5¼	60
355	H	10-B:C	5½	9¾	90
AMERICAN GENERAL PRODUCTS, INC., 1735 Holmes Rd., Ypsilanti, Mich. 48197					
Fire Warden	*BB	5-B:C	2¾	4	150
AMERICAN LA FRANCE, Box 7146, Charlottesville, Va. 22906					
A5A-1	MP	2-A:10-B:C	5	9	41
A5A-1H	MP	2-A:10-B:C	5	9½	49
A10A	MP	4-A:40-B:C	9½	16	65
A20A-3	MP	10-A:40-B:C	18	28	120
FIRE-311	MP	1-A:10-B:C	2½	5	24
ANSUL CO., One Stanton St., Marinette, Wis. 54143					
SY-0211	MP	1-A:10-B:C	2¾	6	19
SY-0512	MP	2-A:10-B:C	4½	13	40
SY-0612	MP	2-A:10-B:C	6	14	46
SY-1012	MP	4-A:40-B:C	10	23	59
BUCKEYE, 102 Industrial Dr., Kings Mt., N.C. 28086					
M1A10	MP	1-A:10-B:C	2½	3½	15
F1A10	MP	1-A:10-B:C	2½	3½	15
M5	BB	5-B:C	2	2¾	10
F5	BB	5-B:C	2	2¾	10
GENERAL FIRE EXTINGUISHER CO., 1685 Shermer Rd., Northbrook, Ill. 60062					
TCP-2½G	MP	1-A:10-B:C	2½	5⅓	20
TCP-5G	MP	2-A:10-B:C	5	10	32
GILLETTE, Prudential Tower Bldg., Boston, Mass. 02199					
9220	MP	1-A:10-B:C	2⅝	3	18
9380	*BB	5-B:C	2	2½	14
KIDDE, 675 Main St., Belleville, N.J. 07109					
H-110(897356)	*MP	1-A:10-B:C	2⅝	4½	19
T-110(897350)	*MP	1-A:10-B:C	2⅝	4½	21
FA-110(896763)	MP	1-A:10-B:C	2⅝	4½	19
FA-240(896764)	MP	2-A:40-B:C	6	9	30
M-110(897353)	*MP	1-A:10-B:C	2⅝	4½	21
T-10	*BB	10-B:C	3¾	5½	18
M-10	*BB	10-B:C	3¾	5½	18
NORELCO, 100 E. 42nd St., New York, N.Y. 10017					
HB 0911	*BB	5-B:C	2½	3	15
HB 1911	*BB	10-B:C	3½	4	20
RC INDUSTRIES, Box 224, Linden, N.J. 07036					
1A10	MP	1-A:10-B:C	2¾	3½	19
2A10SP	MP	2-A:10-B:C	4½	8¼	30
2A10SA	MP	2-A:10-B:C	5	9	35
4A60	MP	4-A:60-B:C	10	14½	51
3M CO., Box 33600, St. Paul, Minn. 55133					
PE-25	AFFF	3-A:20-B	2½ gal. AFFF	28½	95

MP—multipurpose dry chemical (ammonium phosphate); H—Halon 1211; BB—bicarbonate base; AFFF—aqueous film-forming foam; *—decorator type.

home, you may have to face Class C fires in electrical equipment or wiring, when the burning object is also electrically live. Of course, you may want a fire extinguisher that offers protection against all three classes of fires.

In fact, the dominant extinguisher on today's market is the multipurpose, dry-chemical type, with an ABC label. Its ammonium phosphate agent is mixed under pressure with nitrogen. When released, the chemical deprives a fire of oxygen and literally smothers it to death.

Experts favor multipurpose extinguishers for homes and garages. But this type has some limitations. If you use one to put out an upholstery fire, for example, fibers may be left smoldering inside the furniture. A thorough dousing with water is an essential second step.

When dealing with kitchen fires, the multipurpose dry-chemical extinguisher has another shortcoming. Most kitchen fires involve very hot fats and oils. Since the cooling-off time for these burning fats may be longer than the extinguisher's discharge time, such fires need more than smothering action.

A bicarbonate-base extinguisher may be the best one to keep in the kitchen—but not the old-fashioned "soda acid" kind, which has largely fallen into disfavor due to maintenance problems. Today, you can get a dry-chemical, BC-rated extinguisher that sprays a fine bicarbonate powder, which reacts with smoldering fats to form a soapy substance that reduces temperatures and douses the surface fire.

But both types of chemical extinguishers leave a messy residue, which can damage or destroy surfaces, and can also wreck electronic equipment. If you're worried about such damage, you might want one of the new Halon 1211 extinguishers.

Halon 1211 is a liquefied gas that reacts with a fire's fuel molecules to break down the combustion process. The gas is blended with nitrogen, then pressurized for high nozzle velocity. This produces a powerful, far-reaching spray, which means the extinguisher can be used at a safer distance from the fire. Halon 1211 is twice as efficient as CO_2, the traditional gas used in extinguishers. Like CO_2, Halon is suitable for BC fires, and some larger Halon extinguishers are rated ABC.

Since it is a gas, Halon 1211 leaves no residue, and can get at hard-to-reach fires. However, be careful if you have to use it in confined spaces—you can have problems if you breathe too much of the expelled gases. And, although Coast Guard-approved, Halon 1211 is not effective for fires above deck, because it disperses quickly in open air.

The old standby, the pressurized-water extinguisher, is still a consumer favorite. "I like them because they really drench a fire and seep into materials to extinguish smoldering fibers," says fire inspector Robert Early of Melville, N.Y. But pressurized-water extinguishers cannot—and should not—be used on oil, grease, or electrical fires.

The 3M Company has expanded the capability of pressurized-water extinguishers by using Aqueous Film Forming Foam, a fire-fighting agent developed by the U.S. Navy. This concentrate makes water float on flammable liquids. As the agent covers the fuel, an aqueous film drains from the foam bubbles and floats over the fuel surface. The film creates a vapor seal that rapidly extinguishes flames from burning gas or oil.

What's the best weight?

Larger extinguishers are usually more effective simply because they contain more fire-fighting agent. The amateur fire fighter thus has more of a reserve in case of a deadly reflash. But a large extinguisher is useless if family members can't heft it, so it's a good idea to take all potential users along when buying an extinguisher.

"A gross weight of 20 pounds is a realistic upper limit," suggests Alfred Krulee of the National Fire Protection Assn.

What about new, lightweight extinguishers such as Gillette's Captain Kelly or Norelco's Flame Fighter? These small units weigh about three pounds and have two pounds of fire-fighting agent.

"Lightweight extinguishers can be effective and handy in the first moments of a fire," says Krulee. "However, these dry-chemical types discharge in about 10 seconds, and require some skill, which may be lacking."

Check the ratings

Even if you do decide on a

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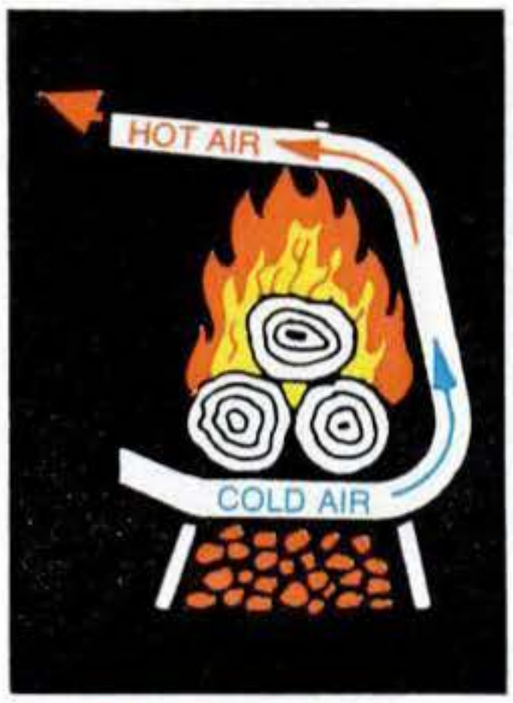

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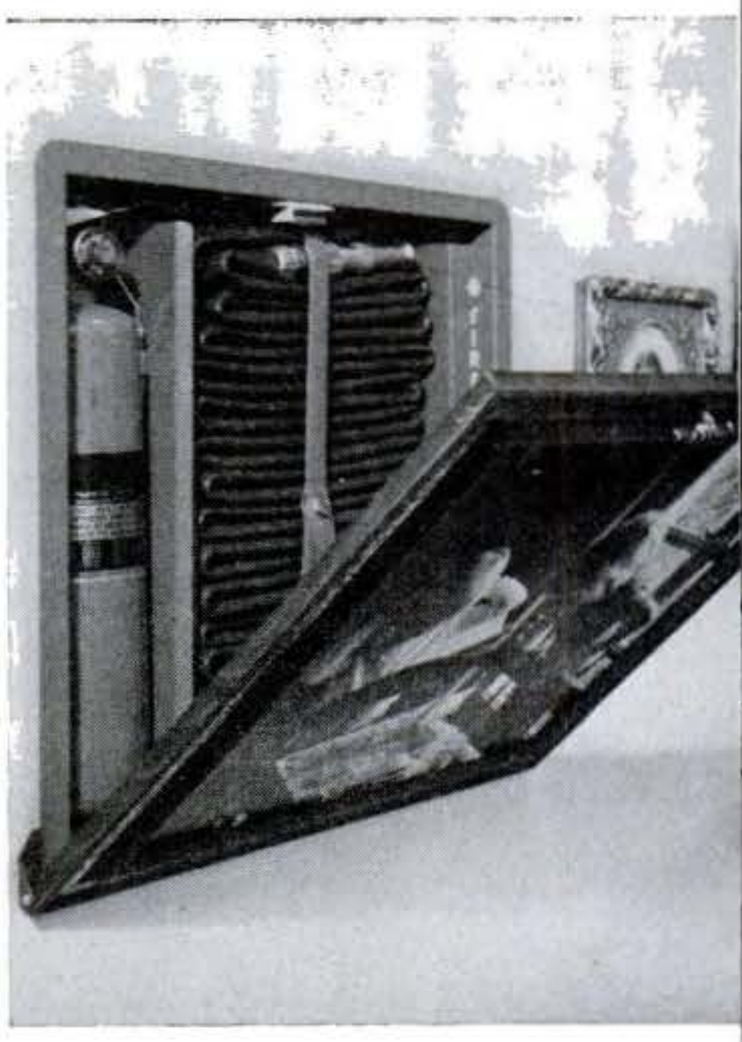

Camouflaged behind a painting (top) American General's Fire Warden is ready for action—if you remember it's there. To encourage monthly checks, Kidde provides a tag with all extinguishers (above). Besides pressure check, extinguisher should be weighed to make certain it contains a full charge. Discharge nozzle should also be inspected to make sure it's not clogged.

lightweight extinguisher, be sure to compare efficiency ratings among brands or models (see table). "Often, extinguishers with the same capacity will have different efficiency ratings because of different discharge weights, nozzle designs, chemical powder grinds, and orifice widths," warns UL's Tom Castino.

Underwriters Laboratories assigns numerical ratings according to an extinguisher's performance

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under controlled test conditions. A 1-A extinguisher must douse an eight-square-foot fire of burning wood panels. A 2-A has to handle a 10-square-foot fire, and so on.

To assign a rating within the B designation, UL testers try out the extinguisher on progressively larger fires in naphtha-filled pans. Since a C designation means only that the extinguisher's fire-fighting agent is nonconducting, Class C has no ratings.

Experts recommend that multipurpose extinguishers for nonindustrial use bear a minimum UL rating of at least 2-A:10-B:C, and hold at least five pounds of dry chemical. A minimum 5-B:C rating is recommended for Halon 1211 and for bicarbonate-base dry-chemical extinguishers. Water extinguishers generally have a 2-A rating.

The final choice

If you're going to buy only one extinguisher for your home, a multipurpose dry-chemical one is your best bet. Most fire authorities also recommend these for cars, RV's, or boats. The old theory was that extinguishers for motorized vehicles had to be effective against oil or gas fires only. But it's quite possible you could be faced with burning electrical wiring or smoldering fabrics in your RV or boat.

Of course, any extinguisher you buy should bear the UL seal. Also be sure that any extinguisher you carry on your boat is Coast Guard-approved and has enough fire power to extinguish a blaze quickly.

Where to put it

Fire extinguishers should be installed in plain view, in an accessible spot near room exits that provide an escape route. And never put the extinguisher near a fire-prone object—the stove or TV, for example.

Mount your extinguisher no more than five feet above the floor, so it's easy to get at. Use a wall bracket for extinguishers on your boat, a Coast Guard regulation. In your car, install a special clip-on bracket under the driver's seat instead of stowing the extinguisher in the trunk.

If you have to use your extinguisher, aim it at the *base* of the fire, not at the smoke or flame. Use a side-to-side motion, sweeping back and forth. When fighting flammable liquids, stand back six to eight feet, or the force of the discharge may splash the fire into other areas, or even onto your face.

Even if there's some pressure left after you fire the extinguisher, powder in the discharge valve could cause a leak, so you should get the unit recharged. (The small, nonrefillable extinguishers should be promptly replaced.) Never try to recharge the unit yourself—the precise mixing and pressurizing of ingredients is a job for a professional service center.

Fire extinguishers are a must because they are your first line of defense in preventing a small fire from becoming a blaze. However, don't forget common sense. "A dry-chemical extinguisher will put out a flaming pan of grease, but so will a lid," notes Robert L. Meyer of the National Safety Council. "And you can use some extinguishers on blazing wastepaper, but you'll do as well with a pitcher of water." PS

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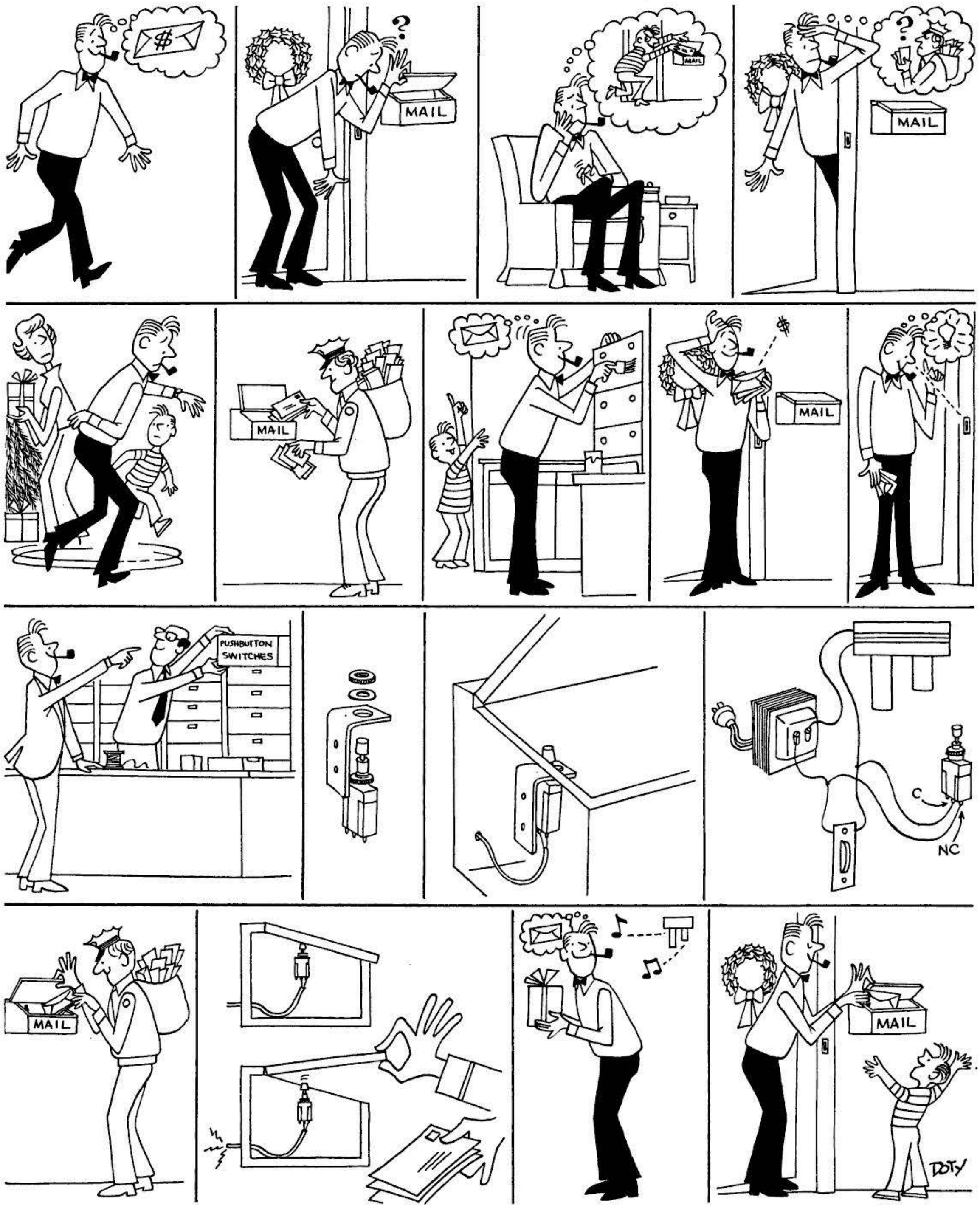
WORDLESS WORKSHOP

By ROY DOTY

Thanks to W. C. Pickard of Cedar Rapids, Iowa for this idea. Send yours (with Social Security No.) to Wordless, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas can be acknowledged.



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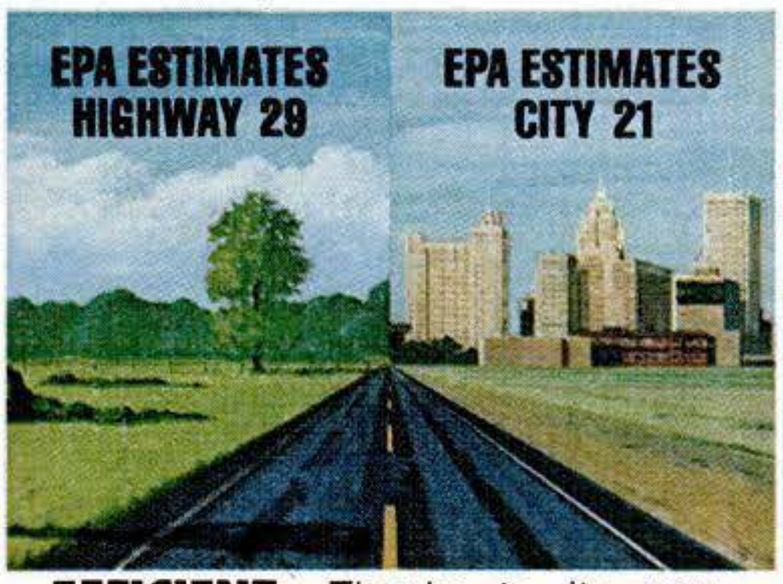

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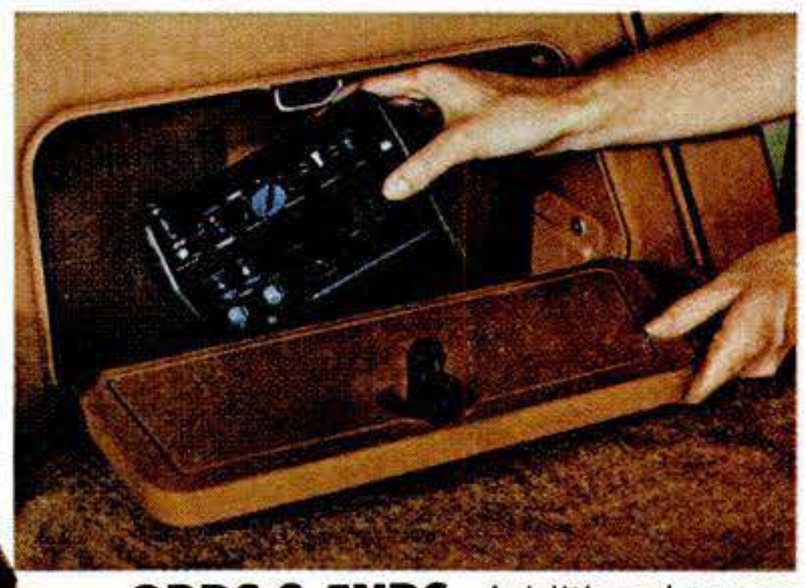

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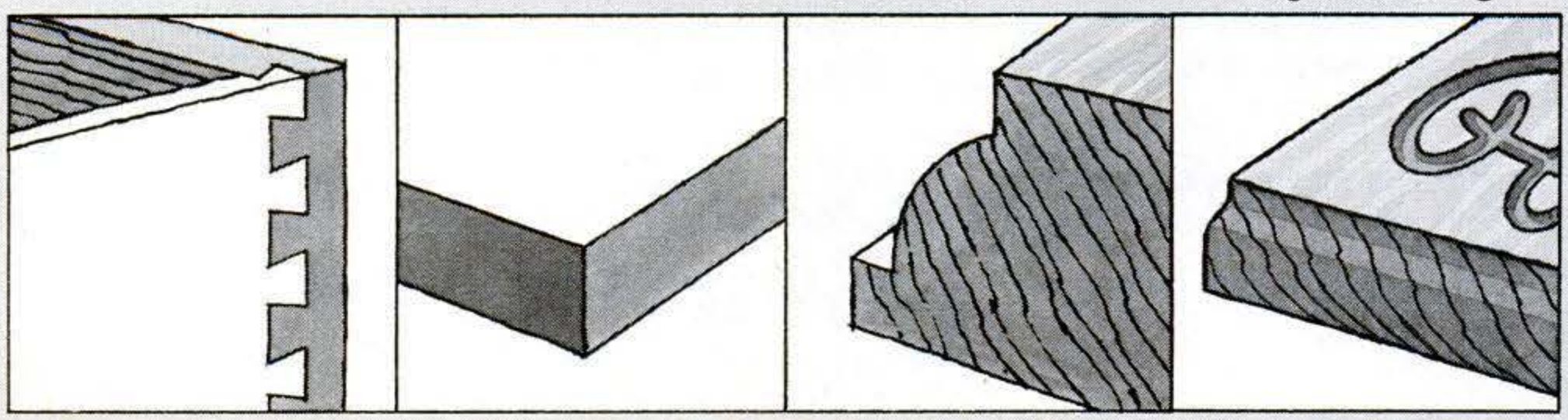

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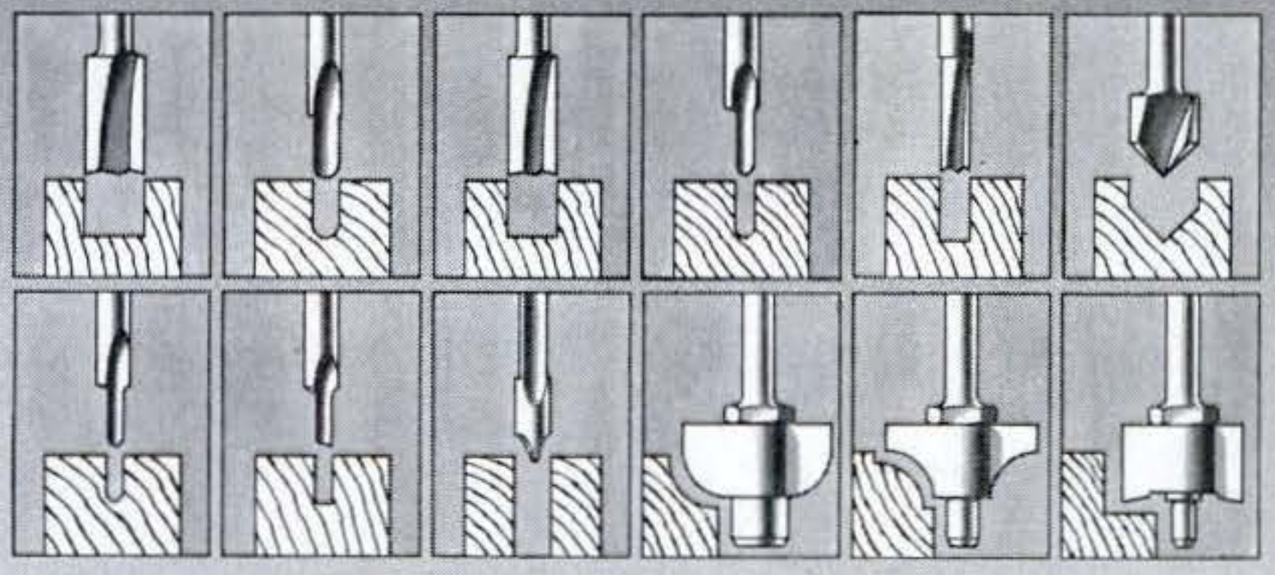
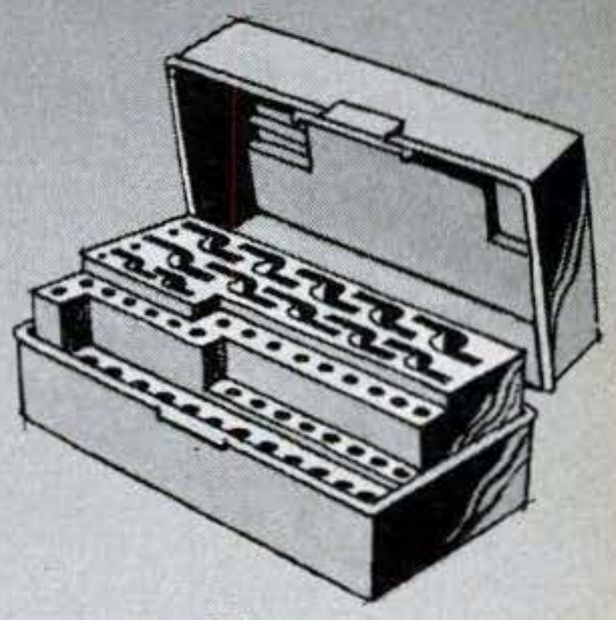
Router and start creating...

bit by bit.





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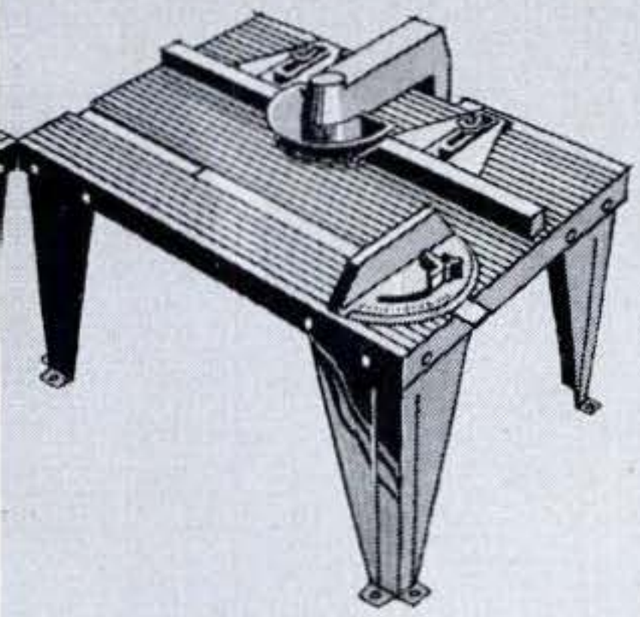

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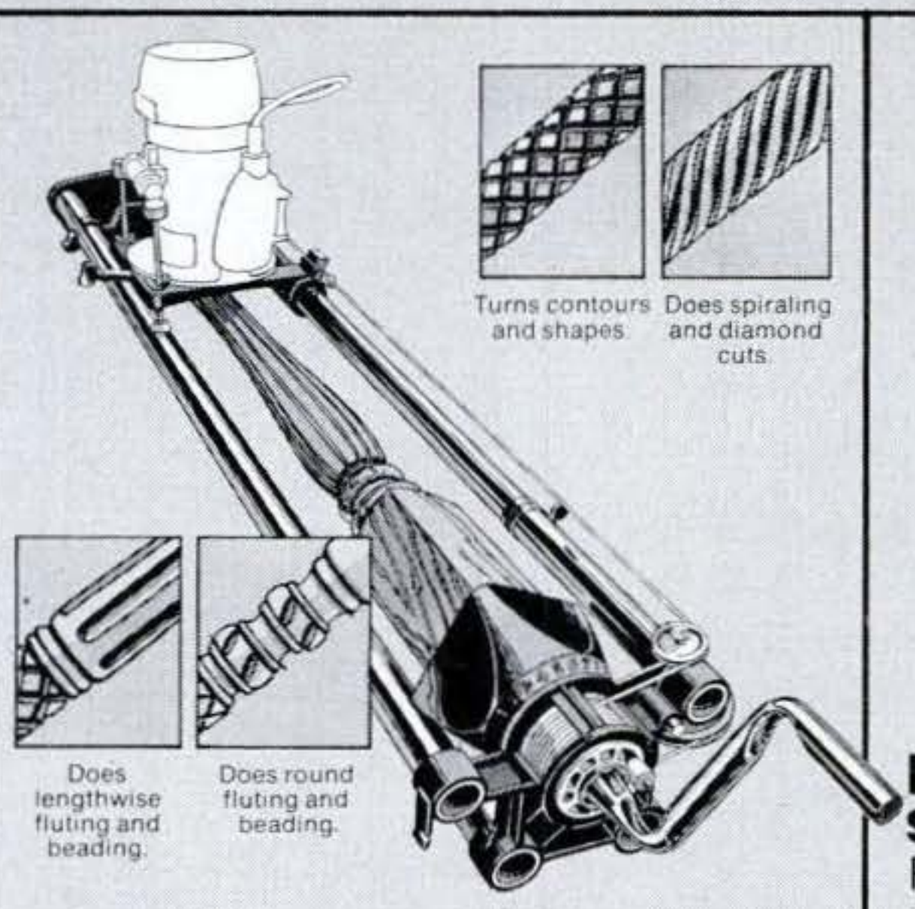

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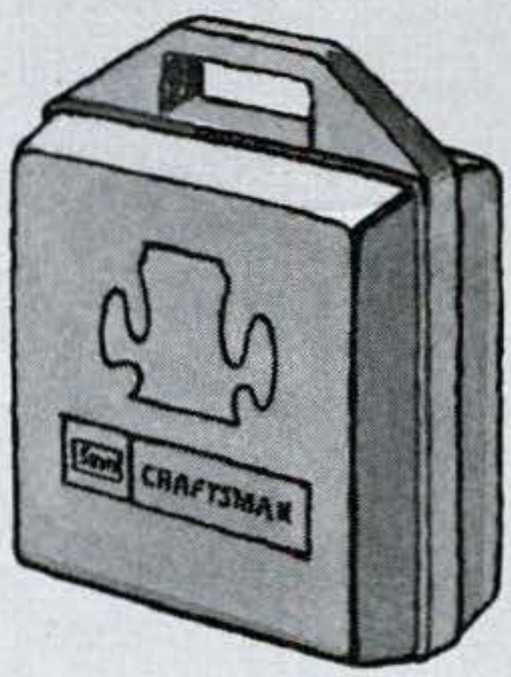

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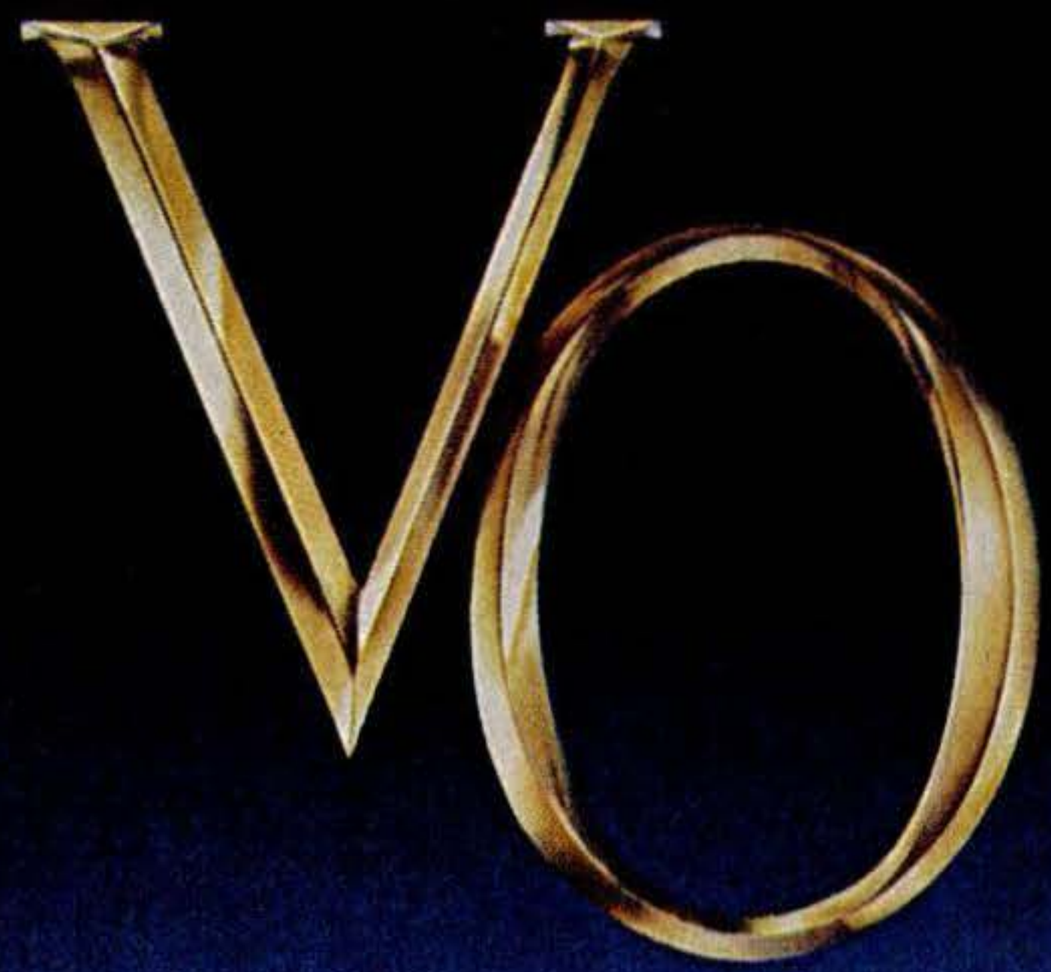

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Popular Science

PS | What's News

The excitement, glamour, and payoff for research and development of commercial and military aircraft have always been connected with machines that fly higher and higher and faster and faster. Few people seemed interested in craft designed to fly lower and slower, no matter what the other advantages might be. Fuel has been cheap and plentiful. You can always drill another oil well, so burn what it takes to reach another speed and altitude record. Basic principles that pointed toward unique advantages of lower and slower flying were largely ignored. The plane shown in our cover photo this month is the most advanced example of taking a fresh look at principles that have been well known to aeronautical engineers for many years. Our aviation editor, Ben Kocivar, has been following this project since he saw scale models at the Paris Air Show six years ago. When the cover photo was taken, the plane had had only about 10 hours of flight time, so Ben has not yet had a chance to fly it. He tells me he has an invitation to fly it sometime in the next few months. You'll learn all the technical details in his story on page 70.

Synthetic mileage

The competition for the highest mpg numbers in the published EPA listings is fierce, and getting fiercer. Manufacturers whose cars come out at the top of the list find they have a very strong sales pitch. Recent reports from the EPA laboratory at Ann Arbor, where the tests are run, suggest that some car makers have tried to slip ahead in the numbers game in a way that offends EPA's idea of fair play. One foreign manufacturer's data fleet was disqualified when a routine sampling showed synthetic oil in the crankcase. As you know, producers of synthetic oil have been claiming a four- to five-percent improvement in fuel economy just by switching to synthetic oil [PS, April '76]. No one is saying there is anything wrong with synthetics or with using them to improve your mileage, but EPA officials say their tests must show what the car can do as delivered by the manufacturer—and no maker at present is delivering cars with synthetic oil in the crankcase, nor do owner's manuals make any reference to synthetics.

We've had many letters from readers telling about their experience with synthetic oil. Most were enthusiastic, but a few expressed disappointment for one reason or another. It has been almost two years since we ran our big feature on synthetics and we would like to hear from all of you who have switched to a synthetic oil. Write to me and tell me about your experience, which brand you use, which filter, whether you've noted an improvement in mpg, easier starting in cold weather, and anything else you think other readers would be interested in knowing. We won't be able to acknowledge the letters individually, but if enough useful information comes from this collective experience, we'll tell you about it in the pages of *Popular Science*.

Home-size wind generators

The man who designed our home-built wind generator [PS, Nov. '72] and the Gemini synchronous inverter [PS, Oct. '75] heads a small company, Windworks, Inc., which has recently been awarded a federal contract for $388,000 to develop a wind generator for home use. Hans Meyer, Windworks president, says Windworks' job will be to design, build, and test a wind generator with 29-foot-diameter blades capable of producing eight kilowatts of electrical power in a 20-mph wind. In windier parts of the country, it could supply 70 to 90 percent of the electrical needs of the typical home, according to Meyer. A GE report done under federal contract estimates a potential of 9.3 million users of small wind systems.

Stirling engine

As a candidate for powering the car of the future, the external-combustion Stirling engine has great promise in theory, but some practical engineering problems stubbornly resist solution. Since the Stirling burns fuel outside the cylinder, almost any kind of fuel can be used, troublesome emissions are low, and very little noise results. In theory, the Stirling should burn fuel with very high efficiency; but according to experts addressing the 12th Intersociety Energy Conversion Engineering Conference, fuel economy is one of the major problems with research vehicles so far. Results of an ERDA/Ford Motor program indicate that a 30-percent improvement in fuel economy would be needed for the engine to be competitive for use in 1985 and beyond. Experts are hopeful that this goal can be achieved with intensive engineering development, but high production costs may be the major drawback. ERDA (now the Department of Energy) is showing its faith in the ultimate future of the Stirling by laying out a timetable for its research and development covering the next six years. The target is 1983 for the manufacturers to decide whether to produce a Stirling-cycle engine for passenger cars. Some authorities think that the main thing Stirling has going in its favor is the ability to burn alternate fuels. By the time it would be ready, petroleum products may be too scarce and valuable to burn in passenger cars.

Fuel-economy labeling

The Environmental Protection Agency (EPA) is trying again on those fuel-economy labels manufacturers are required to put on new cars. It seems that too many customers take the labeled mpg figures at face value and assume that they are entitled to get the indicated mpg. The new labels will be less wordy and emphasize that the numbers are estimates and every driver will get different results because of how, where, and when he drives.

Video discs

The optical video disc described in our February '77 issue has been developed further to give a disc that will play a full-hour program through your home TV set. The earlier disc played a half hour using one side of the record; the new, thicker disc uses both sides. A release from Philips and MCA, Inc., developers of the system, says the present field tests will be extended to insure the performance and reliability of the improved system; the two firms will postpone marketing the system until the fall of 1978.

Hubert P. Luckett

Editor-in-Chief

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Ram-wing X-114

floats, skims, and flies

Zipping above the waves at 90 mph, it saves fuel by flying on a cushion of air

By BEN KOCIVAR

When I first saw models and an early flying version of the ram-wing plane in Germany several years ago, I wondered why they didn't simply call it a flying boat. As the pictures on these pages show, it has a hull, it floats, it has an unusual wing, and it flies. But after talks with pilots and designers of the strange-looking craft, I learned that while it is in fact a flying boat, it also is something more.

The ram-wing plane, or aerofoil boat, is designed to fly most efficiently close to the surface. Thus it takes advantage of a phenomenon called ground effect. Such a vehicle can move people and freight over water faster and cheaper than hydrofoil boats or surface-effect ships [PS, June '74] using less fuel than high-flying aircraft.

Land hopping

Aerofoil boats can also fly over land areas where it is not economical to build expensive highways or rail systems; taxi in water like an ordinary displacement boat to maneuver at slow speeds in harbors; and plane at high speed, just touching the surface like a fast hydroplane. The latter technique is useful when visibility is poor, or when it might be necessary to make quicker stops than would be possible if the vehicle were airborne. Takeoff speed for the latest aerofoil design from West Germany (the X-114) is 40 miles per hour and cruising speed in the ground-effect flight envelope is 90 mph.

What makes it work?

Every time an airplane takes off or lands, its wings build up dynamic air pressure between the plane and the earth's surface, creating a ground effect. The plane rides on a cushion of higher-pressure air. For the aerofoil, this dramatically improves the lift-to-drag ratio by as much as 250 percent. As a result, ground-effect flying requires much less power than flying at altitudes above or out of ground effect. Ground-effect flight also takes much less power than trying to zip along rapidly on the water surface. Ground effect usually becomes evident at altitudes of about half a plane's wingspan. The most desirable altitude, I was told, is about one-quarter the wingspan.

Ground-effect flight is not a new idea. A theoretical study of the concept was developed as early as 1921. And some conventional planes have actually flown with ground effect, at least some of the time. For example, I recall flying seaplanes over the Hudson River with the floats barely off the surface. I would start with power settings that permitted me to make very slow descents from altitude toward the water. Then, as I got into the denser air or the ground effect created by the wing close to the surface, the plane would keep flying effortlessly, never actually touching the water. It was an incredible floating kind of ride.

Extending range

In the 1930's, Lufthansa pilots flying over the South Atlantic cruised long distances in this surface effect only a few feet above the water. They not only doubled their range but also gave their passengers an extremely smooth flight. During the war, crippled planes used this technique to stretch their remaining fuel and get back safely when their engines could not put out enough power to fly at altitude.

Hanno Fischer, a designer and test pilot for Rhein-Flugzeugbau GMBH who helped build and has flown the newest aerofoil boat, the X-114, told me the craft has a lift-to-drag ratio (L/D) of eight in free flight. This improves to 20 near the ground. Eventually he hopes to achieve 25.

What does this mean in comparison with conventional power planes? "It means we can fly a 3000-pound craft at 70 mph in ground effect with only a 70-hp engine," says Fischer. A comparable conventional plane, such as the Grumman American two-seater Traveler, weighs about 2000 pounds and requires a 150-hp engine for free flight at about 140 mph. Quite a power difference. And quite an additional fuel requirement.

First aerofoil

The career of Dr. Alexander M. Lippisch, who died in Iowa, was long and varied. Born in Munich in 1894, he helped design zeppelins, innovative sailplanes, and tailless supersonic delta-wing planes. He led the team that developed the rocket-powered Me-163B, the fastest military plane in World War II.

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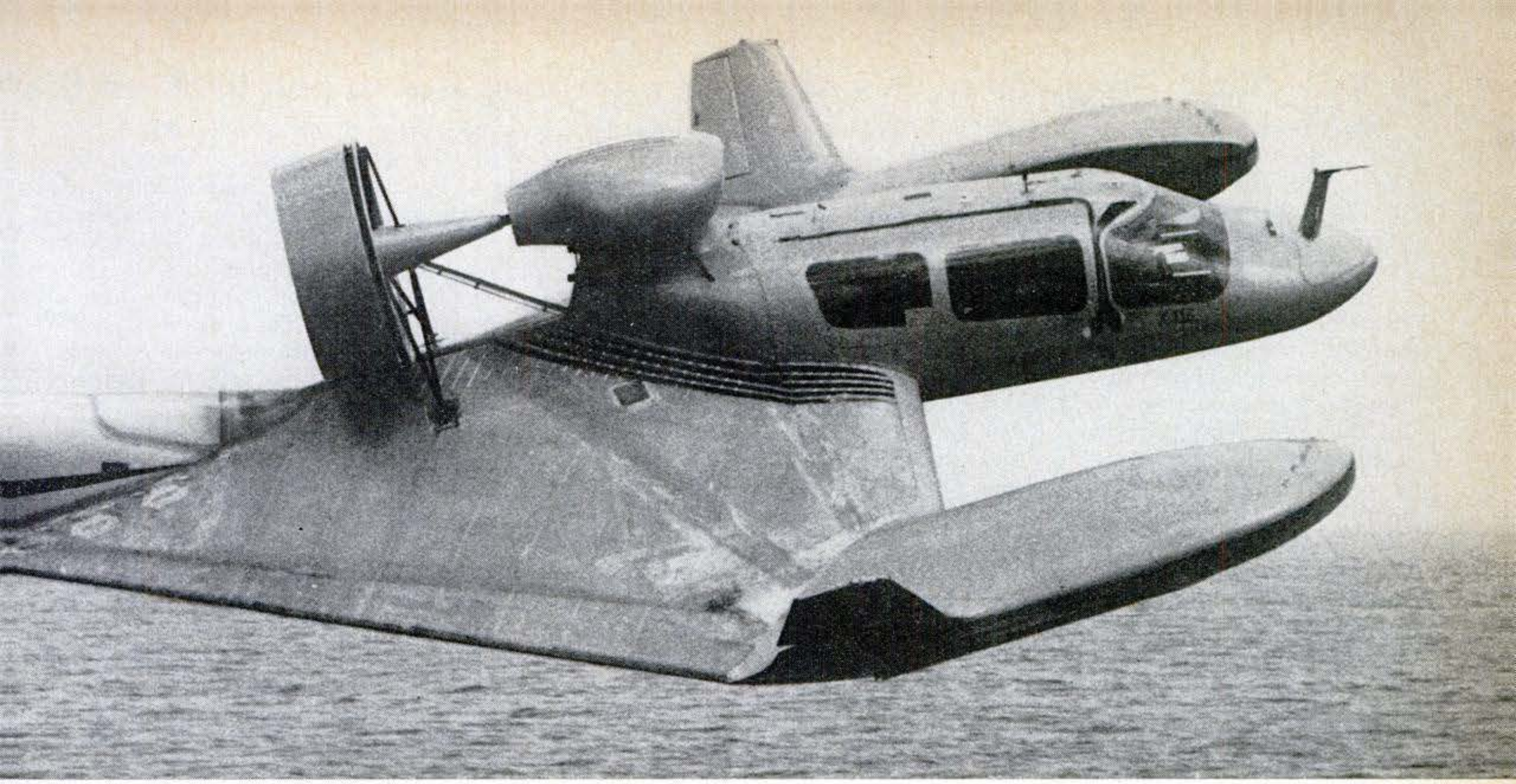

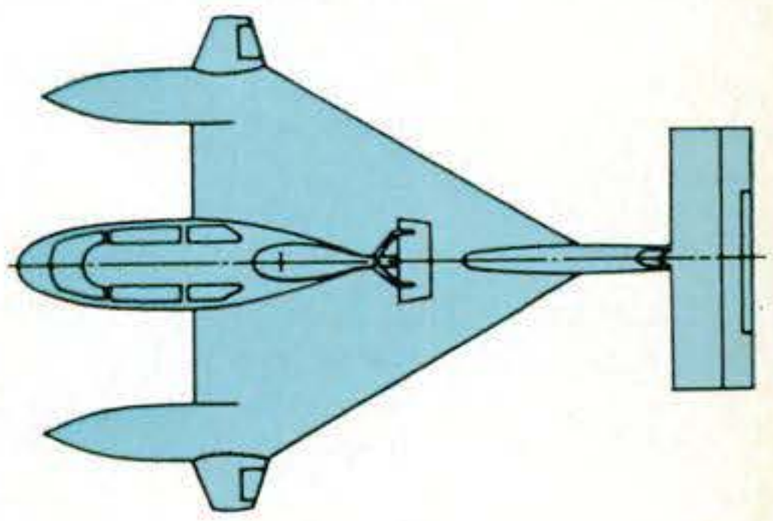

Hovercraft-like plane has a reversed-delta wing (diagram) with a shallow cavity beneath it that provides ground-effect lift at very low heights. Air cushion created during flight enables the X-114 to skim economically only a few feet above land or water. It can leap over low-lying obstacles and also fly like a conventional plane. A pusher prop gives it a cruise speed of 90 mph, with a 1200-mile range. The experimental craft was made in Germany by Rhein-Flugzeugbau.

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X-114 flyer: "To jump over a ship, the pilot only has to pull back on the

After the war Lippisch worked for the U.S. Air Force and Navy. In 1959, when he was with Collins Hydrodynamic Laboratory at Cedar Rapids, Iowa, he started developing and flew his first aerofoil boat, the X-112. He conceived it as an "aerodynamic surface-effect, or ram-wing, vehicle," and considered it the best solution for a general-purpose medium-speed transport over waterways. In 1967, the West German Defense Department became interested and awarded contracts for further development. This resulted in the X-113 single-seater and the present X-114, a 40-foot-long seven-seater with a 22-foot wingspan. Current development is being done by Rhein-Flugzeugbau, an affiliate of VFW-Fokker, the same company that is developing the Wankel-powered Fanliner and Fantrainer [PS, March].

I learned some intriguing things about this unusual machine from technical papers and interviews with German pilots and engineers who have flown the plane.

The delta-wing design of the Lippisch aerofoil is most unusual; unlike other delta-wing planes, this one uses the straight side of the triangle as the leading edge, while the other triangle sides taper to the fuselage in the rear. Also, the wings droop dramatically, with float pods terminating the wing tips.

"The reverse delta shape does several things," said Hanno Fischer. "Most important, it provides longitudinal stability. On conventional wings the center of pressure [which provides lift] shifts forward from 45 percent of the chord [or cross section] when the wing is in ground effect to 25 percent at higher altitudes. This shift prohibits practical use of the ram-wing principle for surface-effect vehicles. The reverse delta with negative dihedral [droop] avoids this shift."

Flying high

I had heard that the earlier X-113 had flown not only in ground effect but also at altitudes of up to 2000 feet. How does it get this kind of power?

According to Fischer, the aerofoil needs more power to take off from the water and overcome water drag than it needs to maintain flight just above the water. For normal flight, the engine is throttled back to conserve fuel. Because it has this extra power to get off the water it can also hop up over obstacles such as built-up land areas, low mountains, snow, mud, ice—or ships.

"To jump over a ship, the pilot only has to pull back on the control wheel," says Fischer. "It can hop 66 feet high without trouble. Then you just level out and let it settle back automatically to its former altitude close to the water."

Flying at altitude, of course, requires additional power—and the loss of fuel conservation.

The reverse-delta shape and negative dihedral give other benefits, too. When the boat is in the water, only the small trailing tip of the wing is immersed. This creates much less drag than a conventional delta platform in which the whole trailing edge of the wing would be in the water. At the same time, the negative dihedral makes an immediate "air tunnel" under the wing that gives lift as soon as forward motion begins during takeoff.

The compact delta shape also provides structural advantages. Normally, good lift-to-drag ratios are best obtained by long slender wings like those of high-performance gliders. However, as lift increases, so does induced drag. Because the aerofoil is used in denser ground effect, much of the lift is provided by "pressing" on the ground. This lift, about 35 percent of the total, pays no penalty in induced drag.

Lighter wing

As a result, the aerofoil wing can be a relatively narrow, compact, stronger, and lighter wing providing more lift with less power.

Fischer described another interesting advantage. The aerofoil is absolutely stable. Once the correct altitude has been established, the craft holds altitude automatically—it can be flown hands off. To make landings, a pilot just reduces power and the plane comes down and flares (levels off) automatically.

The aerofoil is amphibious. Retractable landing gears fold back into the wing-tip floats. These can be lowered one at a time to help make turns when the craft is afloat on the water. There is also a tail wheel. There are no water rudders.

The ducted-fan, 200-hp reciprocating engine of the X-114 has a reversible-pitch prop. Thus the craft can be braked or even moved backwards when it is on the water.

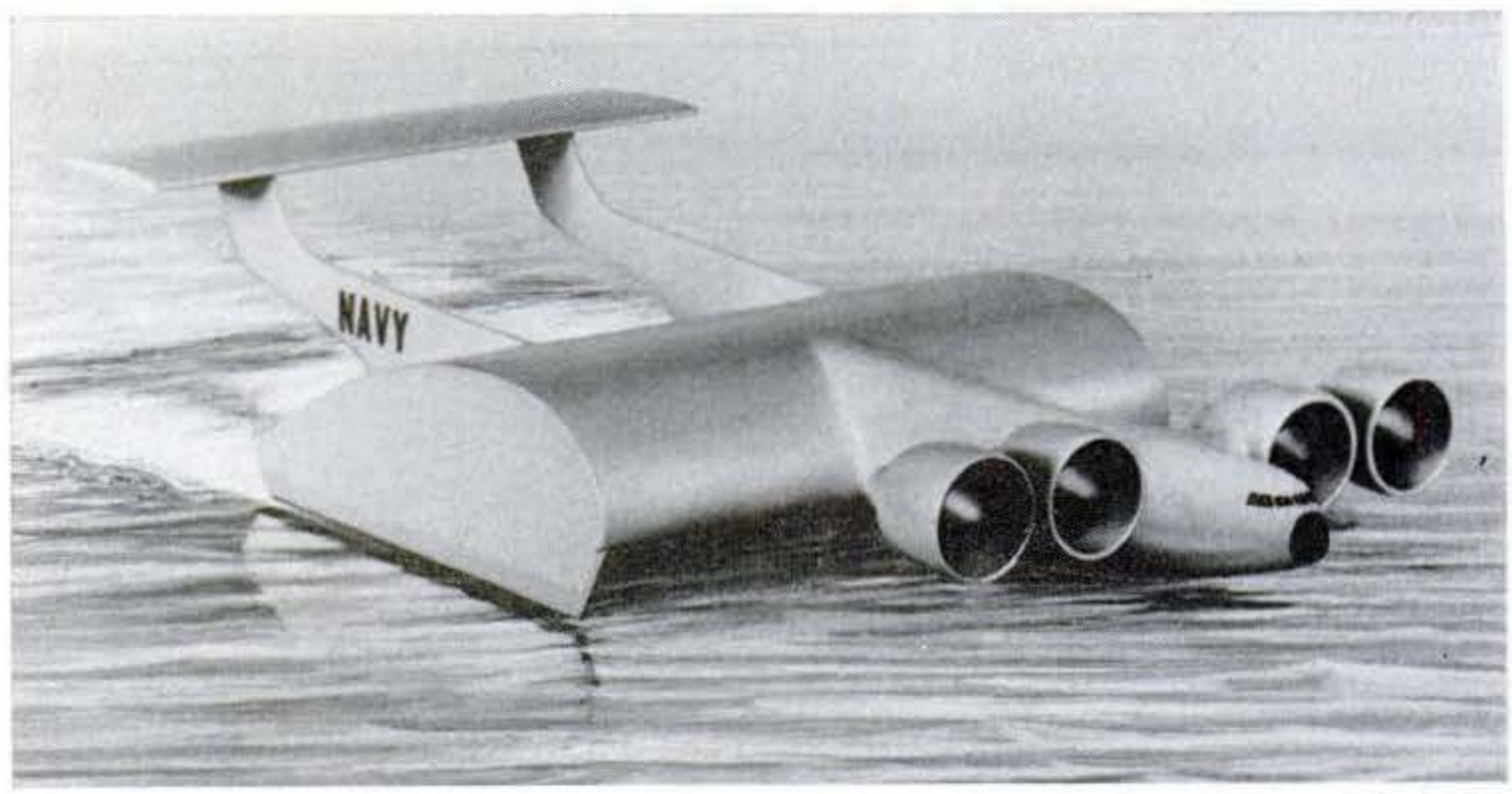
Flight controls are conventional, with dual control wheels and rudder pedals. The instrument panel has one unusual item: An extremely sensitive radar altimeter can measure altitude over average wave heights to within two inches. It can also be set to measure absolute height over the water surface.

Winglet controls

The plane has unusual small winglets that stick up at angles from the wing-tip floats. Although these look like the NASA winglets designed to reduce wingtip vortex [PS, Sept. '76], they are actually the aileron controls used to make turns in flight.

The X-114 is now being tested by the West German Navy in the Baltic Sea, near Kiel. Military interest, beyond straight research, is for possible use of the X-114 as a search-and-rescue craft. The current research program is aimed at flying across the Baltic Sea, where 80 percent of the waves are five feet high, Fischer told me.

I also learned from Washington sources, who preferred not to be quoted, that although the U.S. Navy is presently pursuing no major active program, it is "keeping



Navy cargo vehicle would rotate the back of its turbofan engines down 30 degrees during takeoff. As it developed forward motion, Lockheed-Georgia's 700-ton design-concept craft would be blown off the water much like a Hovercraft.

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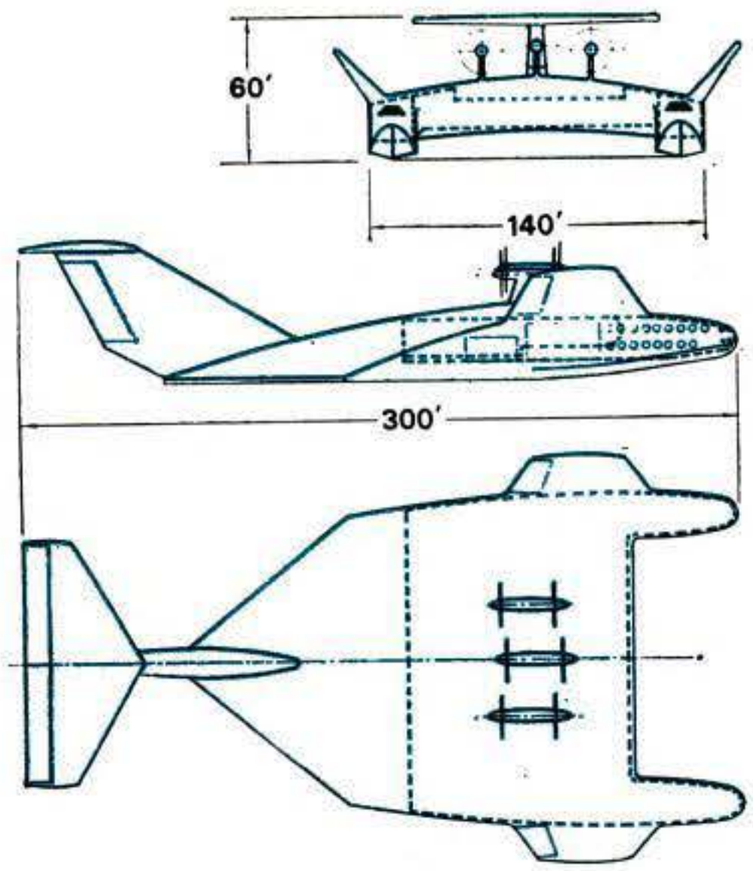
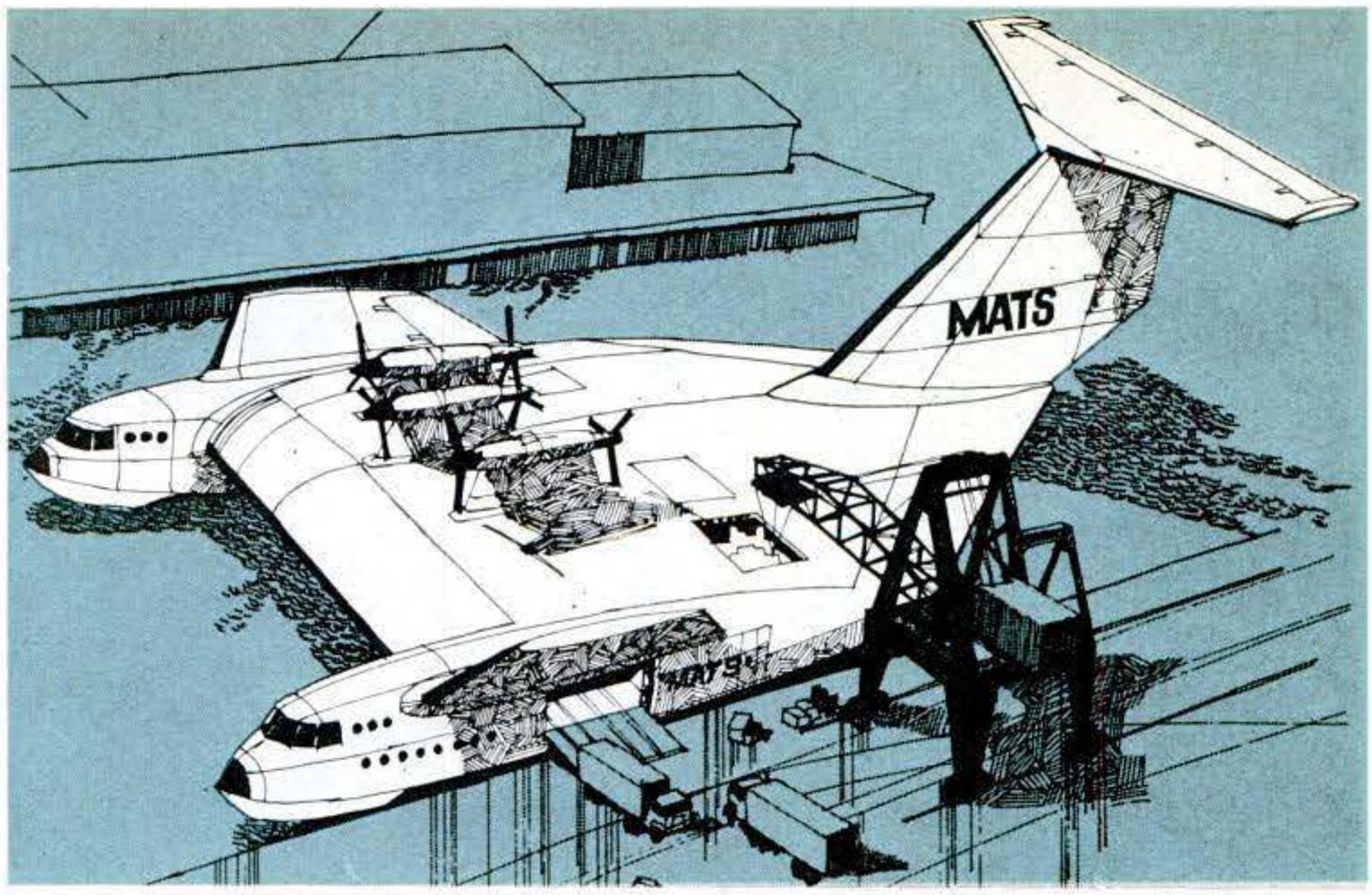
craft's control wheel"





Ocean-going surface-effect ship conceived by the Lippisch Research Corp. would weigh 300 tons. Vehicle could carry freight and passengers at low cost and at speeds several times higher than those of conventional shipping.

current" on the West German research as well as monitoring Soviet progress on very large multi-engine versions of the aerofoil boat.

Russia's Ekranoplan

Photos have appeared of early Soviet designs that look like exact copies of early Lippisch models. The Russians are also reportedly flying a large 10-engine, 500-ton experimental "Ekranoplan." One authoritative source estimates that one version of the craft, designed for antisubmarine warfare, could fly 350 mph at 25 to 50 feet over the water.

A sketch of the Russian craft shows eight jet engines that are mounted on a stubby canard forward wing and aimed so that their jet blast hits the water and bounces back up under a big rear main wing. This creates a high-pressure area and provides lift similar to a Hovercraft's.

Another intriguing design is by Lockheed-Georgia. It's a study for the Navy of a big four-engine turbofan-powered craft. Lockheed has been considering a machine that will weigh 1.4 million pounds, carry a 441,000-pound payload, and cruise 3.8 feet over the water surface at Mach 0.4 (about 300 mph).

The Lockheed proposal, pictured on these pages, is for a huge logistics vehicle to transport large amounts of cargo long distances at speeds much higher than those of conventional surface transportation. This design is for a craft 238 feet long with a wingspan of 108 feet. I was told that no models or smaller versions have yet been made.

The future?

Dr. Lippisch proposed three possible future types of aerofoil boats:

- Small vehicles for sport, recreation, and inland transport missions on rivers and lakes. These would be one-half to three tons in weight and cruise 60 to 100 mph.
- Medium-size aerofoil boats that would weigh up to 50 tons and cruise at 200 mph.
- Large ocean-going versions of the ram-wing type that could be 1000 tons or more. He predicted that these would not be able to fly high out of ground effect, but could rise to at least half their wingspan. This would enable them to fly over high waves and small obstacles. Their cruising speeds would be about 350 mph.

Military uses of these craft could include fast patrol boats, antisubmarine craft, troop carriers, or landing craft.

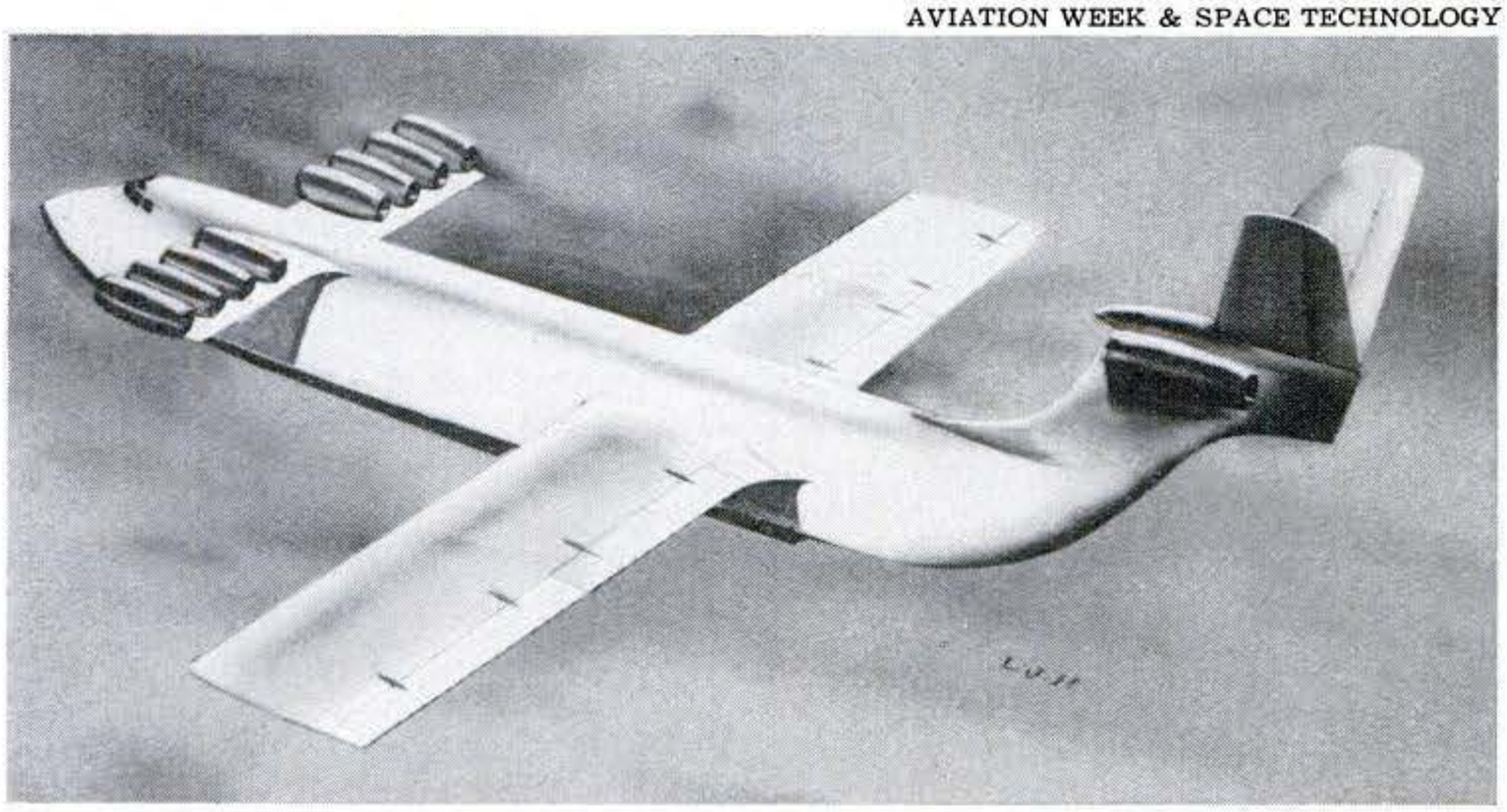
How about civilian uses?

Originally, the ground-effect plane was proposed for relatively undeveloped areas. In the few short years since Dr. Lippisch got his project off the water, however, we have run head-on into the energy and fuel crisis.

Stretching fuel

The supersonic Concorde is running into serious opposition because it uses a lot of fuel per passenger—even though it saves considerable chunks of time. Airline companies and aircraft manufacturers are worried about the rising prices of fossil fuels and are hoping for fuel-saving designs and engines. It is no secret that the aerofoil concept has been on the back burner for several years. With the obvious need to stretch the world's limited fuel reserves, however, this concept of going farther on less fuel by flying closer to the ground may soon get more urgent consideration by aircraft designers. PS

AVIATION WEEK & SPACE TECHNOLOGY



Russian craft gets lift from air bubble caused by jet blast bouncing off water beneath its main wings. Eight-engine aircraft was reportedly tested in 1974; newest versions, suitable for antisubmarine warfare, may go 350 mph.

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Swing-beam crank system quiets opposed-piston diesel

A balanced-force crank cuts noise and vibration while smoothing output torque

By DAVID SCOTT
SLOUGH, ENGLAND

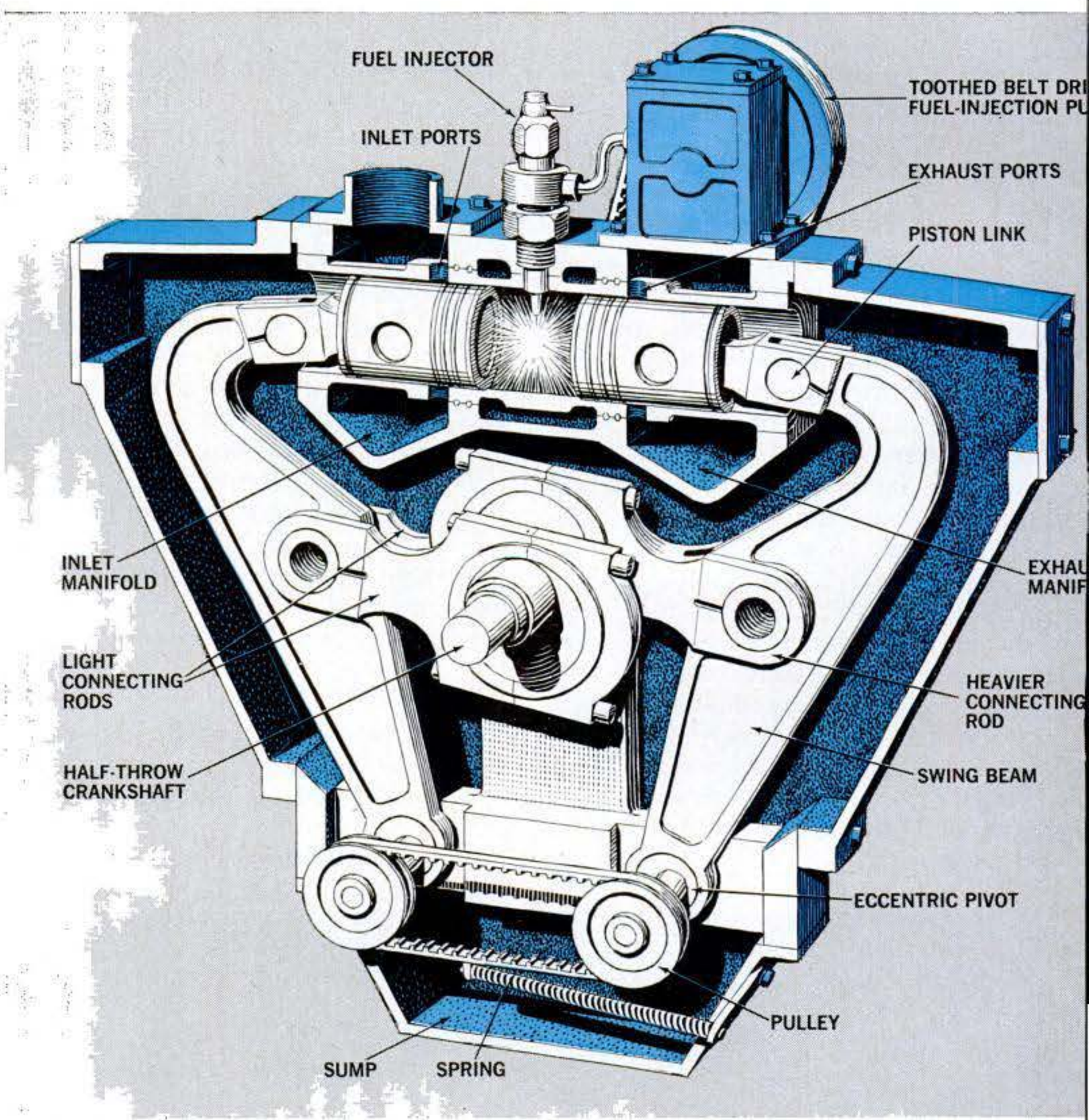
Can a diesel be as quiet as a gas engine? Yes—with a radical break from orthodox designs.

That's the strong view of Donald Tryhorn, manager of the research group at the engineering firm of Armstrong Whitworth & Co., Ltd., of Slough, near London. And he's aiming to prove it.

"We have a completely new layout, but one using conventional parts," he told me. "It's a swing-beam, opposed-piston two-stroke with extremely low noise and vibration, smooth output torque, low emissions, and also the potential for quite an efficient power-to-weight ratio."

He adds that, after ignition, the compression ratio can be lowered for optimum performance. Cooling is dead easy—so easy, in fact, that it may even be possible to eliminate the ubiquitous, noisy, power-eating fan.

The heart of this exciting engine is a balanced-force crank system that absorbs all the high-pressure forces and virtually eliminates characteristic diesel knock. It leaves the crankcase as merely an unloaded oil-holding box and not—as is usually the case—a sounding board for combustion noise. Like most clever ideas, this one is beautifully simple and logical.



Swing beams linked to opposed pistons in this diesel are pivoted at the bottom and connected at midpoint to con rods that balance load on crankshaft, reduce noise transmission. Short links to pistons compensate for arc of beam swing.

One cylinder, two pistons

The combustion chamber in this design is formed between two opposed pistons in one horizontal cylinder: There's no cylinder head to contain explosion forces. Even though such open-chamber designs are already in use, this one gets the power out in a unique way that licks a host of mechanical problems and has certain other advantages as well.

As can be seen in the drawing, the paired pistons are linked to the top ends of parallel vertical beams that pivot at their lower ends.

Connecting rods are joined between the midpoint of each beam and the crankshaft, which is centered on a line between the two small-end bearings. A single rod on

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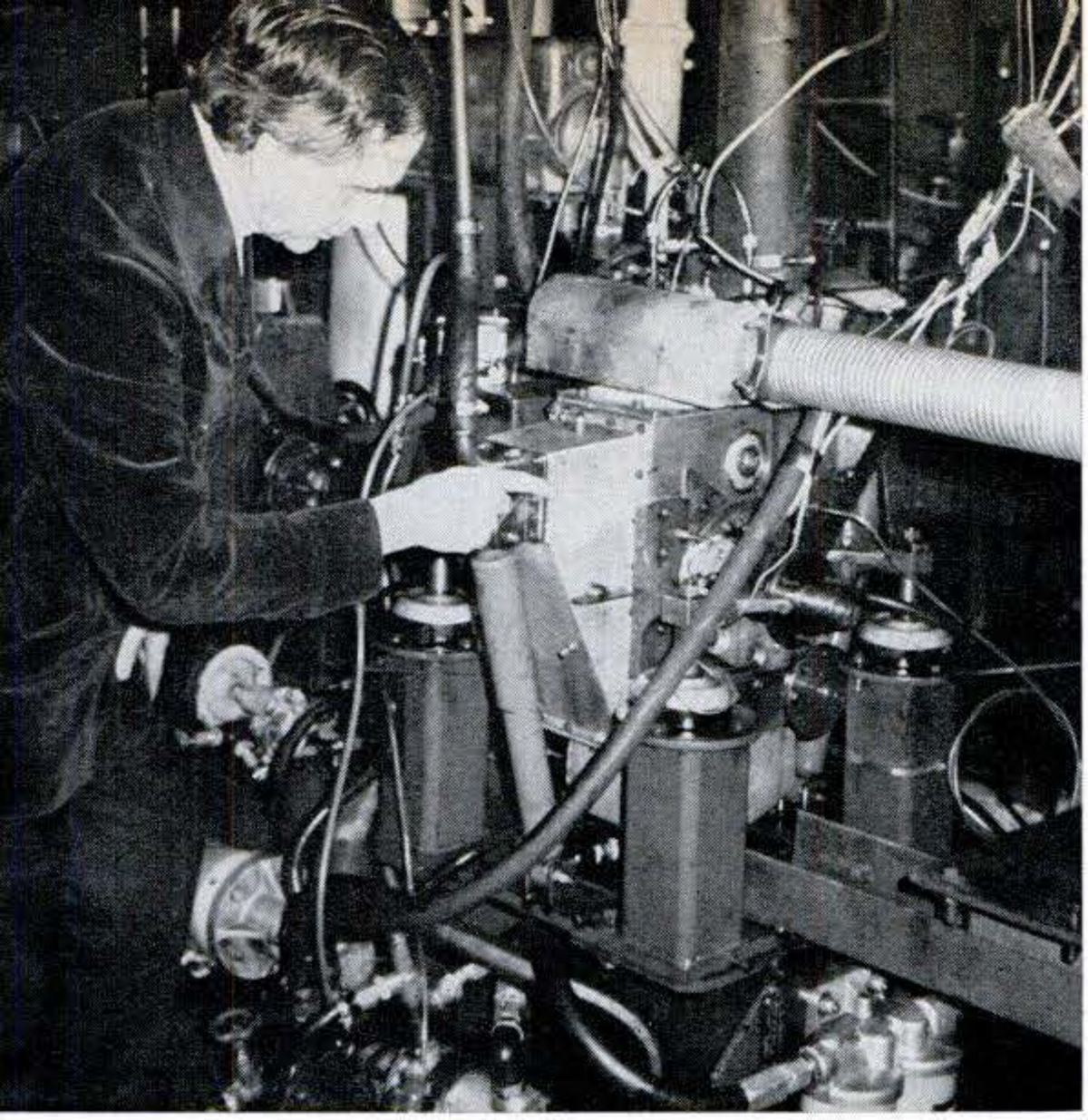
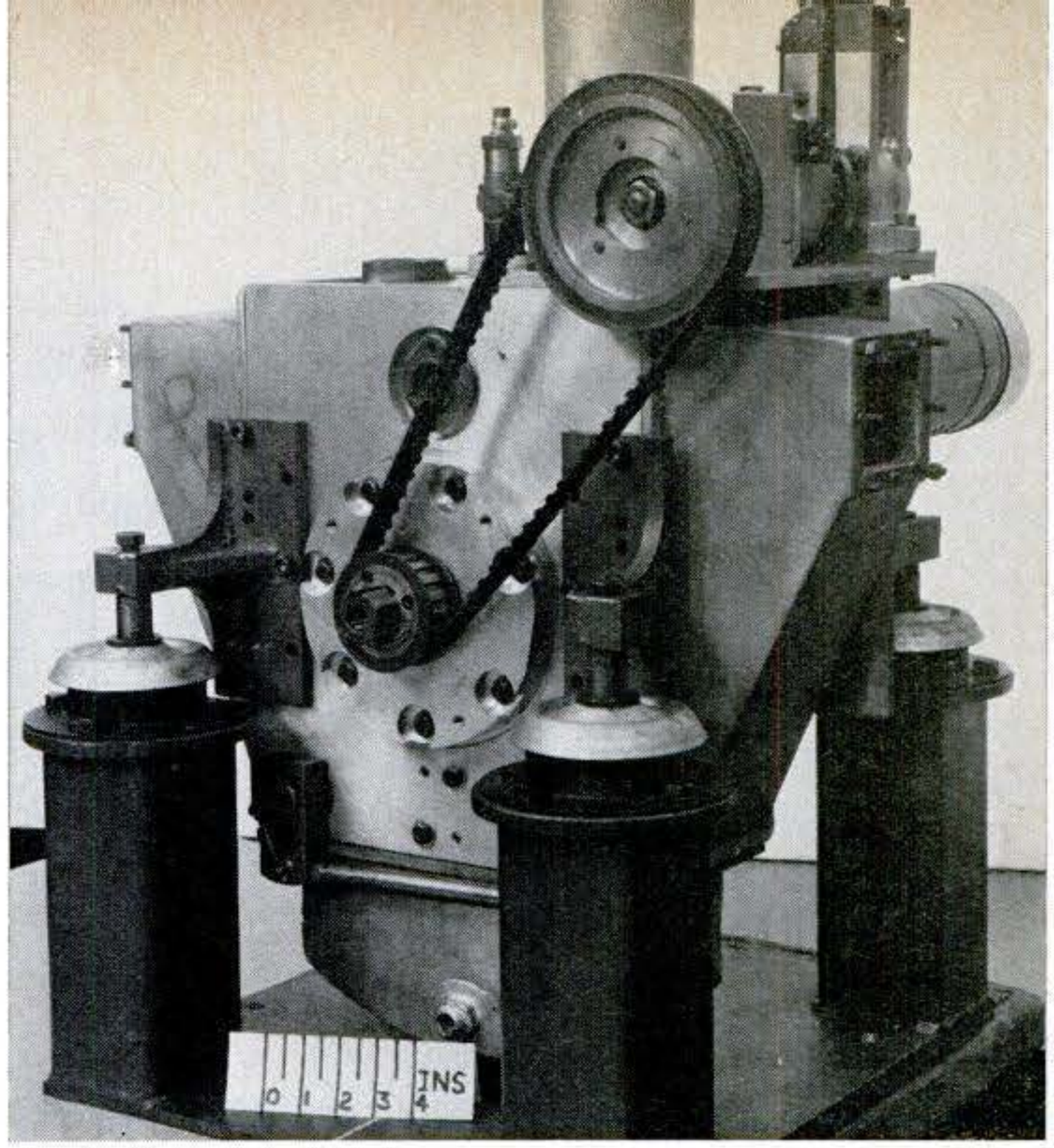


Experimental 475-cc single-cylinder diesel engine has run over 400 hours on its test bed at Slough, delivering 20 hp continuously, 26 hp at peak. Here the author finger-checks the prototype for vibration, finds it surprisingly low.



Machined largely from solid metal, the test engine's 240-lb. weight could be greatly reduced in production. Toothed belt drives fuel-injection pump. Compressed air is used for scavenging, but engine-driven blower is planned for later models.

one side is flanked by a lighter pair on the other. Combustion loads applied through the beams are therefore diametrically opposed and totally balanced.

Since the crankshaft itself does no more than transmit torque, its main bearings are very lightly loaded. As a result, little noise reaches the supporting casing that normally acts as a noise box. Because of the lever action, the crank has half the throw of the piston stroke and can be a stubby, camlike unit with large, closely spaced pins having substantial overlap for strength.

Still other solid benefits are derived from this crafty geometry. Compression ratio can be varied just by slightly rotating the beams, which pivot on eccentric bearings. Thus the diesel can be started at the high 20:1 ratio needed for initial fuel ignition, then dropped to about 13:1 to reduce emissions, friction losses, and stress on working parts.

The change is automatic, controlled by a spring-tensioned toothed belt looped between pulleys on the two eccentric shafts. After the engine starts, the one-way torque pressure of the beams against the eccentrics drags the belt around against its retaining spring, shifting the fulcrums to widen piston spacing at top dead center (TDC).

More time for better burn

Extra combustion time during the critical burn period is a hidden bonus of the crank layout. This is because piston TDC occurs at bottom dead center (BDC) of the crank. At this point, crankpin motion around piston TDC is subtracted from the straightening movement of the connecting rod, instead of being added to it as in conventional engines. Reversing the usual action slows piston travel around this point, resulting in more complete combustion and further reducing emissions.

Smooth operation is also provided by the inertia of the heavy swing beams. They absorb half the explosion force as they're accelerated to engine speed, then return this energy to the crankshaft on the following inward stroke when there would normally be no torque delivery. These masses act like a reciprocating flywheel, making it possible to use a rotary one of lighter weight.

"Because of this," Tryhorn explains, "torque fluctuations with just a single cylinder are comparable to those of a four-cylinder four-stroke engine. A small one-cylinder industrial engine becomes a practical proposition. And a multi-cylinder automotive unit would require a less robust transmission than is needed for conventional diesel engines."

Cooling the engine is simple—there's no cylinder head, and the only hot area is the short combustion space in the central portion of the cylinder liner. Very little water is needed, and Tryhorn believes that, in a vehicle, the cooling fan could be eliminated entirely. The heater matrix might even serve as the radiator, with exhausted air bypassed to the atmosphere when internal engine heating wasn't needed.

After more than 400 test-bed hours, a 475-cc (29 cubic inch) single-cylinder prototype has delivered sustained output of 20 hp at around 3000 rpm. It reached a peak of 26 hp at well below the 4000-rpm design speed—a very respectable figure for the displacement, particularly from a first-born experimental unit. Refinements in subsequent models may well improve on this performance.

At present, the two-stroke is scavenged by compressed air from an external supply, but a suitable engine-driven blower is being prepared.

Where to now?

Armstrong Whitworth is now building an improved prototype of the same capacity, but three- and four-cylinder versions are already on the drawing board. The four-cylinder—with two-liter (122 cubic inch) displacement—has a calculated output of 70 to 90 hp, depending on emission requirements. The low noise level and smoothness of this diesel could make it a winner for cars and trucks, and Tryhorn expects to be talking soon to engine manufacturers. If global pressures for economy and clean air keep up, he believes, his swing-beam crank system could be on the road in the next decade. PS

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Damadian's supermagnet

How he hopes to use it to detect cancer

A physician thinks a physicist's tool—nuclear magnetic resonance—can make cancer cells broadcast their presence

By SUSAN RENNER-SMITH

Dr. Raymond Damadian jabbed his finger at the diagram he'd just drawn, then leaned forward intently. "What you should realize," he said, motioning toward his lab, "is that you're on the threshold of a new era—the age of electronic medicine."

When I first entered Damadian's laboratory in Brooklyn's Downstate Medical Center, it looked unlike any medical research lab I'd ever seen. There were familiar notes—the beeping and thumping of intricate machines, the squeaking of caged mice, the hum of electronic instruments. But some of the equipment looked out of place. I spotted a welder's torch, a router, and a drafting table piled high with blueprints.

Dominating the scene was an impressive structure: a six-foot-high gleaming metallic hoop. Damadian grinned with pride as he pointed to it. "That," he said, "is our human magnet. It's superconducting, with a 1000-gauss field, and a bore large enough to hold a man. It's taken us a year to build."

The magnet explains the machine-shop look of Damadian's lab. A medical doctor with degrees in math and physics, Damadian is also a self-taught engineer, computer programmer, and machinist. He needs all these skills to pursue his goal. For Damadian wants to prove that a physicist's tool—nuclear magnetic resonance (NMR)—can detect, and maybe treat, human cancer [PS, Mar. '73].

"With NMR, the body's own natural elements can be made to give off radio signals," he said. "Then each atom becomes a tiny atomic radio transmitter, broadcasting its situation to the world, and telling what's going on in the chemical world deep inside the tissues.

"The beauty is," he added, "that the technique is non-invasive. You don't need surgery or X-rays. The RF signals are like the radio, TV, and other broadcast signals we're constantly exposed to."

Until Damadian came along, NMR was used mainly to analyze organic compounds. Many experts were skeptical of his ideas.

To date, however, he's demonstrated that NMR can indeed detect differences between healthy tissues and some kinds of cancerous tissues. And he's shown that the technique can detect a tumor in a living animal. But he's still working on successfully applying NMR to humans. One of his problems has been that the equipment available commercially is designed to analyze test-tube samples. So Damadian has had to design and build NMR equipment for analyzing live animals.

How NMR works

Physicists have long known that many atomic isotopes have "magnetic nuclei." A magnetic field pulls at these tiny nuclear magnets, making them precess, or wobble, just as the force of gravity makes a spinning top wobble on its axis. Each of the nuclei wobbles at its own natural frequency—but this frequency depends on the strength of the magnetic field.

The field from Damadian's giant magnet separates the magnetic nuclei into two or more groups, according to the energy they have. In hydrogen, for example, a few nuclei have enough spin energy to oppose the field. These are in the higher energy state. But most of the nuclei are in a lower energy state, lined up in polarity with the field.

"But I can feed these hydrogen nuclei in the lower state a burst of extra energy from a radio transmitter," Damadian said. "If the RF energy matches their natural frequency, they'll absorb that energy and resonate, just as a tuning fork resonates when excited by its natural frequency."

The resonating nuclei now wobble more strongly. The energy they absorbed lets them reverse polarity and flip over to the higher energy state. But it's only a temporary promotion. Once the radio pulse is shut off, the nuclei stop resonating and flip back to the lower energy state. As they go, they beam back the radio energy they absorbed. Physicists can pick up that "atomic broadcast" with a radio receiver.

The frequency at which each nucleus broadcasts varies according to the types of atoms in the molecule

Continued

Riding into the giant magnet's bore, Dr. Larry Minkoff wears a chest-fitting radio coil. It beams signals from the shielded cable into his body, where atoms absorb, then rebroadcast, them. Fed via computer to a TV screen (below, near right), the signals create a picture of a cross section of Minkoff's chest. At far right, comparison of peaks on oscilloscope's traces of mouse muscle shows the difference in signals emitted by atoms in cancerous tissues. Such traces might lead to more effective treatment.

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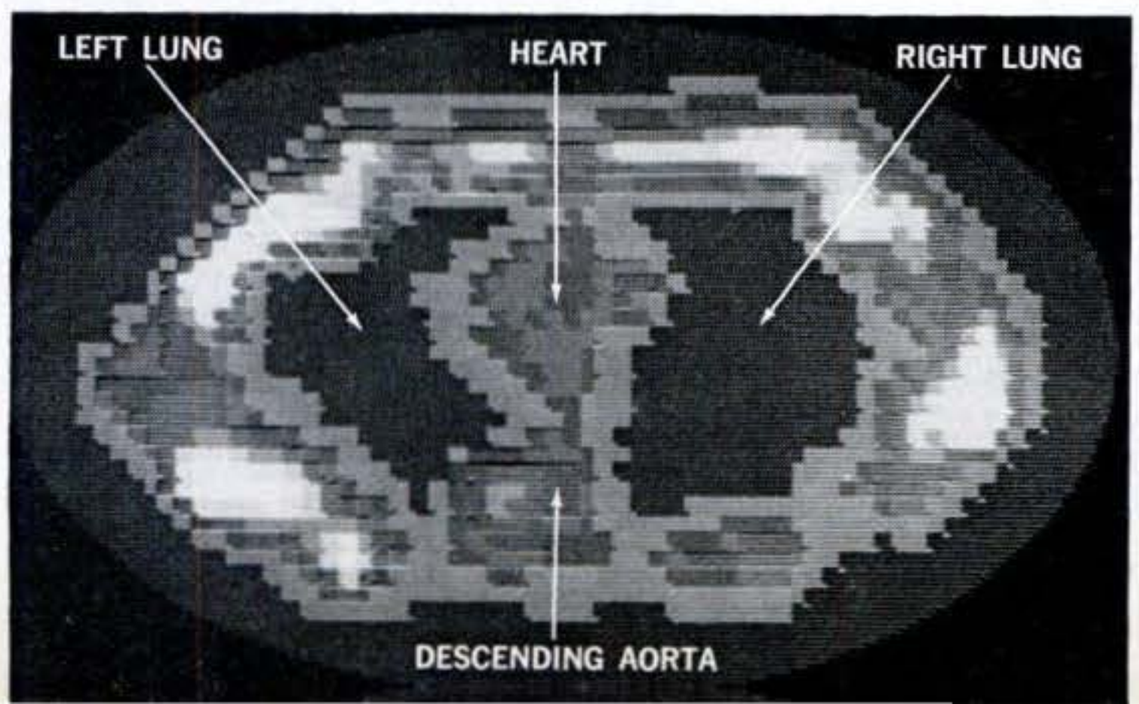

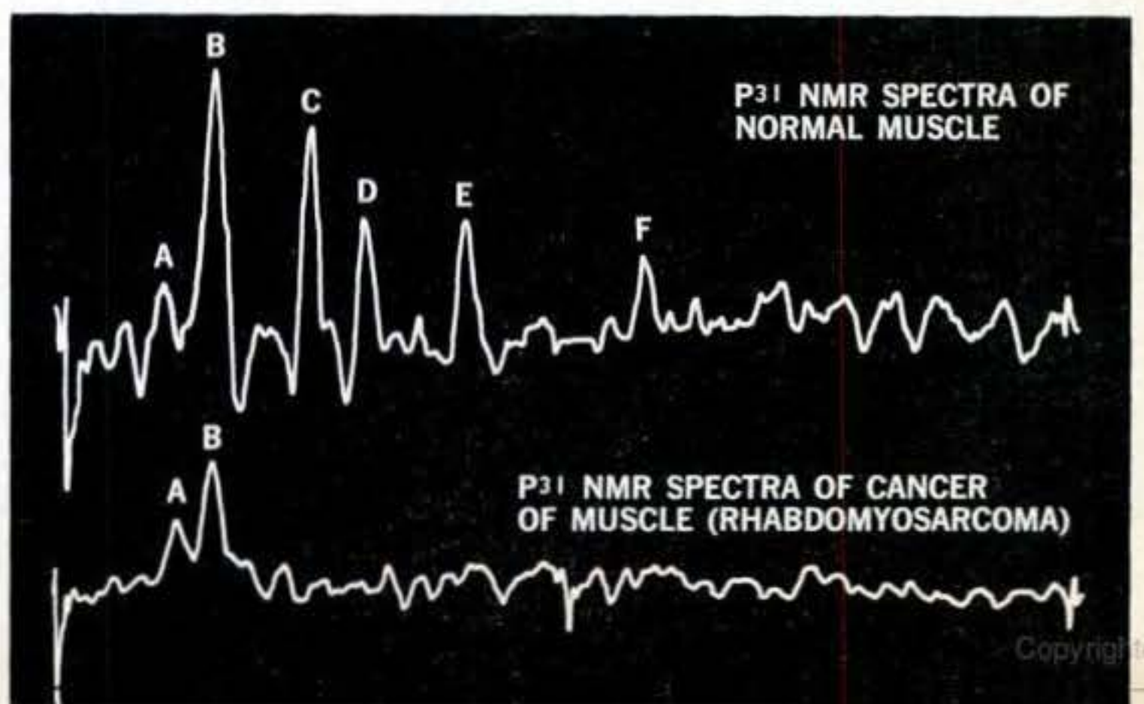

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and how closely they are packed together. These slight frequency changes make NMR an extremely useful tool. Over the past 20 years, physicists have identified the "call letters" of the magnetic nuclei in most molecular combinations. Today, scientists can take almost any substance and use NMR to identify its atomic components.

Because most of the elements that make up the body contain magnetic nuclei, Damadian is convinced that NMR has promise as a cancer-detection technique.

Cancer's wavelengths

Pathologists know, of course, that cancer cells are different from normal ones. One difference: Normal tissue is about 70 percent water; solid tumors are about 90 percent. And the water molecules in cancer cells move about more than those in normal cells.

Knowing this, Damadian thought that the NMR signals broadcast by the hydrogen in normal and cancer cells should be different. At first, he tested his theory with standard NMR equipment. To generate the magnetic field, he used a superconducting magnet. These magnets are wound with substances that have no electrical resistance when they're cooled by liquid helium to near absolute zero (4 K). Superconducting magnets produce very stable fields, yet, once started, they consume no energy at all.

To beam RF energy into the sample, Damadian used an NMR spectrometer. This sends a radio pulse through a coil wrapped around the sample. The nuclei in the sample absorb the energy and resonate. Then the pulse is cut off, and the nuclei give off a signal as they flip back to their original state. The coil picks up this signal and feeds it to amplifiers. The amplified signal is then fed to an oscilloscope.

With this equipment, Damadian measured "relaxation time"—the time it took the hydrogen broadcast from various animal tissues to fade. He found there was a difference. Cancerous tissues took longer than normal to release the energy.

Next, Damadian began testing human tissues. In a paper published in the *Proceedings of the National Academy of Sciences* (April, 1974) he reported on his studies of 28 different kinds of tumorous tissues. In all cases, the NMR signal was different for tumorous and normal tissues. Breast tumors, for example, had a relaxation time of 1.080 seconds, three times longer than the mean time for normal breast tissue, 0.367 seconds. Cancerous lung tissues had a mean relaxation time of 1.110 seconds, compared with a normal average of 0.788 seconds. Since then, researchers all over the world have corroborated, and extended, his findings.

Damadian also experimented with a technique called continuous-wave NMR: Instead of sending a 100-microsecond pulse into the sample, he tunes a continuous RF signal through a small frequency band (for hydrogen, it's 24.1 to 24.2 MHz). Nuclei of the same element will resonate at slightly different frequencies, depending on their molecular environment. So, as the signal for a given element is tuned, a series of peaks appears on the oscilloscope.

> "What you are seeing here is a record of signals from atoms deep within those tissues and organs"

Such oscilloscope traces are like chemical fingerprints identifying the substance. Like the relaxation times, the spectra of cancer tissues are clearly different from those of normal tissues.

To show me, Damadian flipped open his log book, and pointed to two oscilloscope traces (see diagram). "Here are the spectra of a normal muscle obtained by my student, Jason Koutcher," he said. "See those peaks? Each stands for a different radio frequency resonated by various phosphate compounds in the muscle. Now look at the rhabdomyosarcoma (cancerous muscle) spectra."

A few peaks were missing. "Cancer has altered the chemistry of that muscle," he said. "Do you realize what this means? Pathologists could use the spectra to dope out the exact chemistry of different tumors." Today, tumors are not chemically analyzed, but are identified visually, through microscopic analysis and comparison. Knowledge of the chemical abnormalities in a tumor might even lead to more effective treatments. Damadian pointed to the "B" (inorganic phosphate) peak in each tracing. "See, it's changed position in the cancerous muscle," he said. "It's shifted 40 Hz. For the first time, we've identified a frequency that's different in cancer tissue. We might be able to beam in destructive radio signals at that cancer alone. Healthy cells would be unharmed—they wouldn't absorb energy at that frequency." This is pure theory, of course; it hasn't been tried yet.

Focusing the signal

All of the results reported so far are based on tissue samples. When he first tried to detect cancer in an animal, Damadian ran into a major problem. Because animal tumors are embedded in normal tissues, the NMR signals were mixed. With standard equipment, it was impossible to get clear discrimination between the tumors and the normal tissue surrounding it.

So, Damadian dropped his test tubes and moved over to the drawing board . . . and to the computer . . . and to the machine shop. He found a way to shape—thus focus—the magnetic field by adding specially designed RF and DC coils to the equipment.

Damadian considers his field-focusing-NMR (FONAR) process a significant technological advance. "You've got this small 8-mm spot in the center of the magnet's bore," he said. "Signals will come only from this spot. Any part of the anatomy outside the spot will give no signal."

This means that Damadian can focus the NMR signal deep within a living sample, measure the relaxation time of one tiny section, or pull a spectrum of its chemical makeup—all without signal interference from outside that tiny area.

The FONAR signal can be monitored on an oscilloscope—but it can also be displayed on a TV screen. In this application, the living sample is slowly rotated within the magnet's bore so that the FONAR spot can be focused on a cross section of its anatomy. Signals from the sample are relayed to a computer, which assigns a color code based on the amplitude of each signal. The color-coded signals are then displayed on the screen.

"It's as if you took a large salami, sliced it across, then took that slice out and looked down at the cut surface," Damadian said. He showed me a reproduction of the FONAR scan of a mouse's thorax. "This shows the images of organs at the level of the cross section. What you are seeing here is a record of signals from atoms deep within those tissues and organs."

The video display could speed up detection of abnormal masses. "By monitoring the intensity of the hydrogen signal coming from an animal," Damadian explained, "we're actually measuring the water content of its tissues." If the scan reveals a mass with an abnormally

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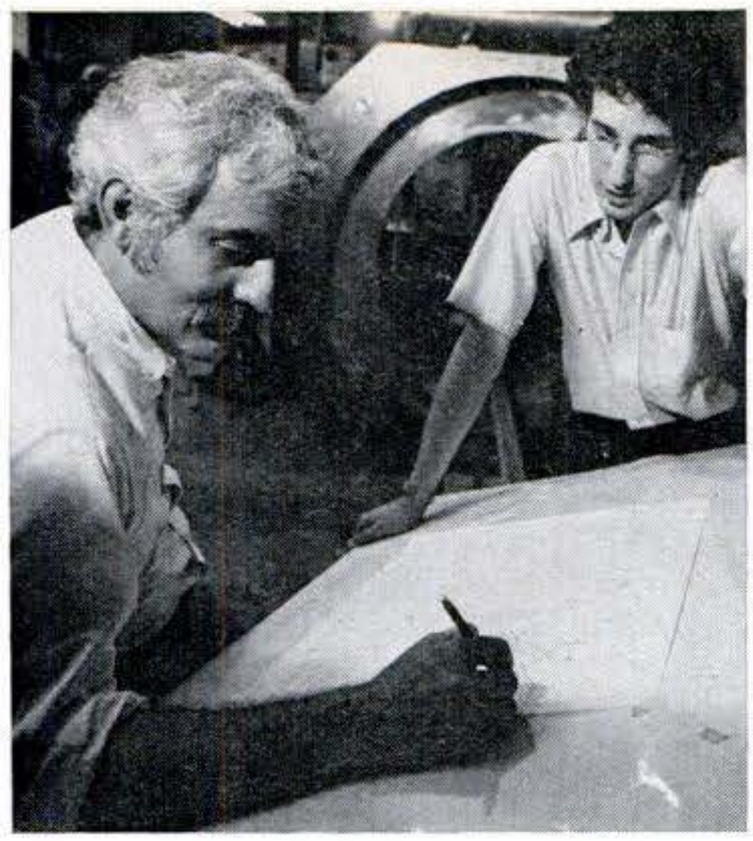

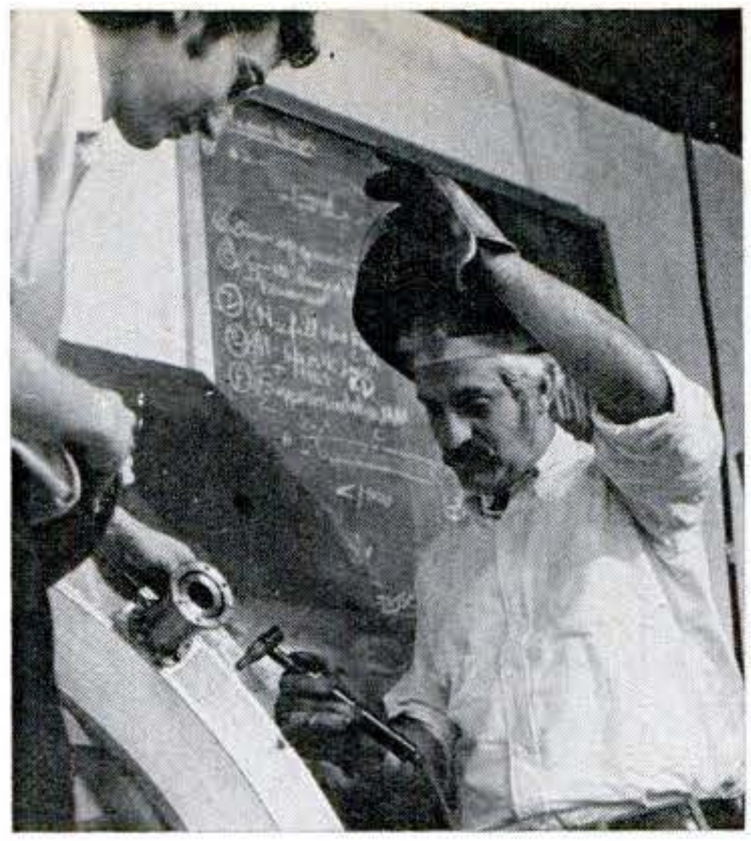

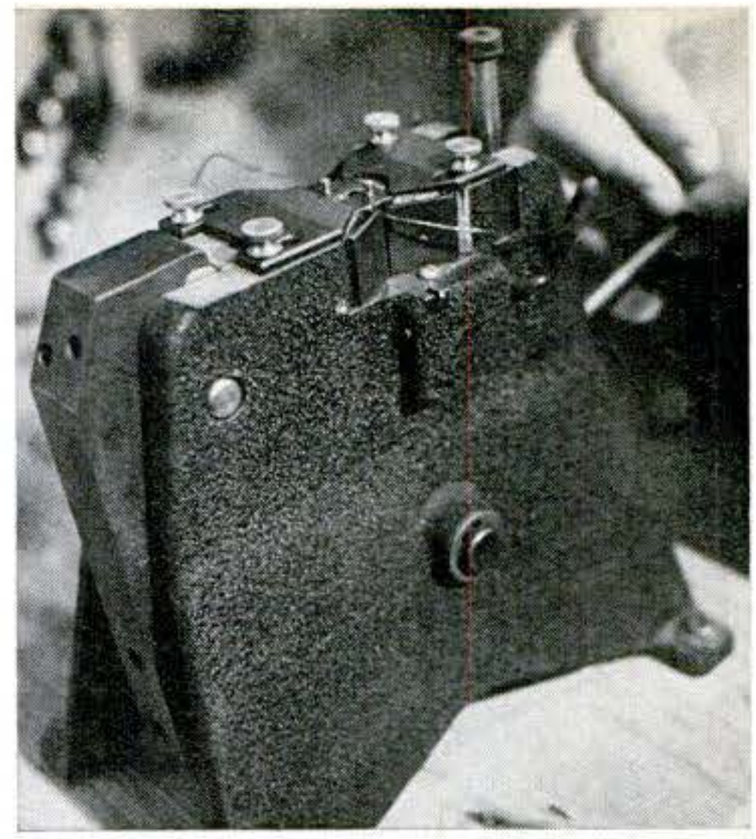

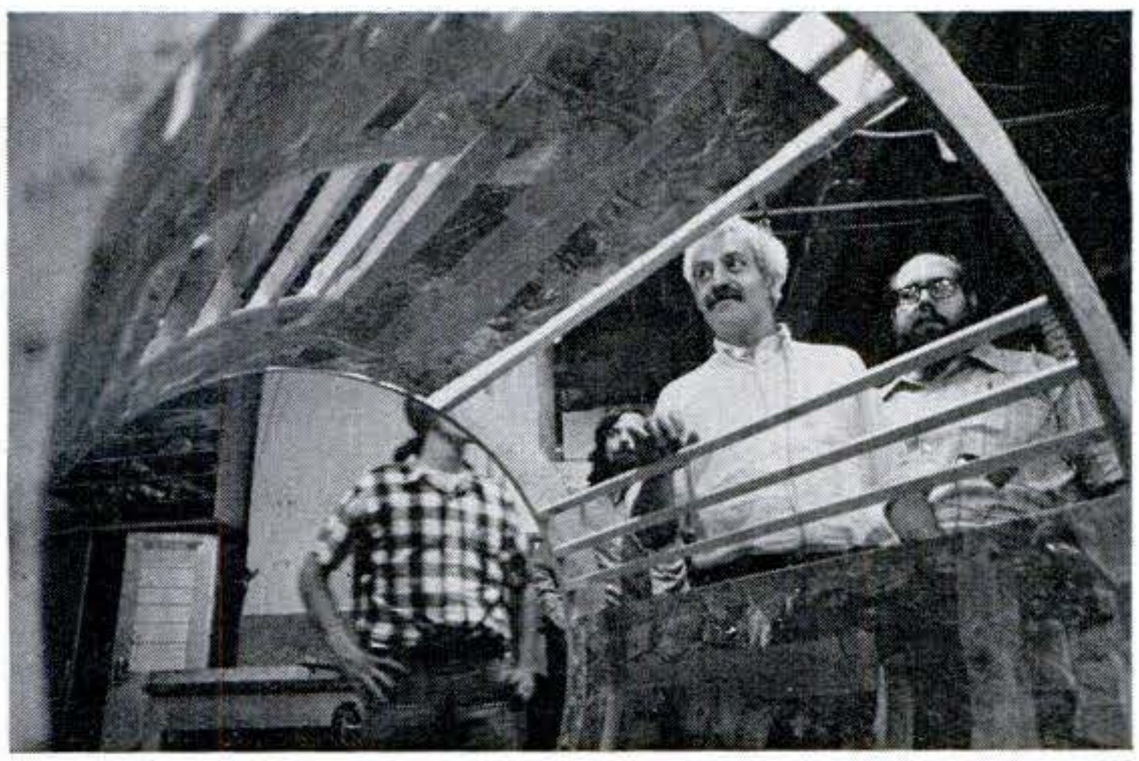

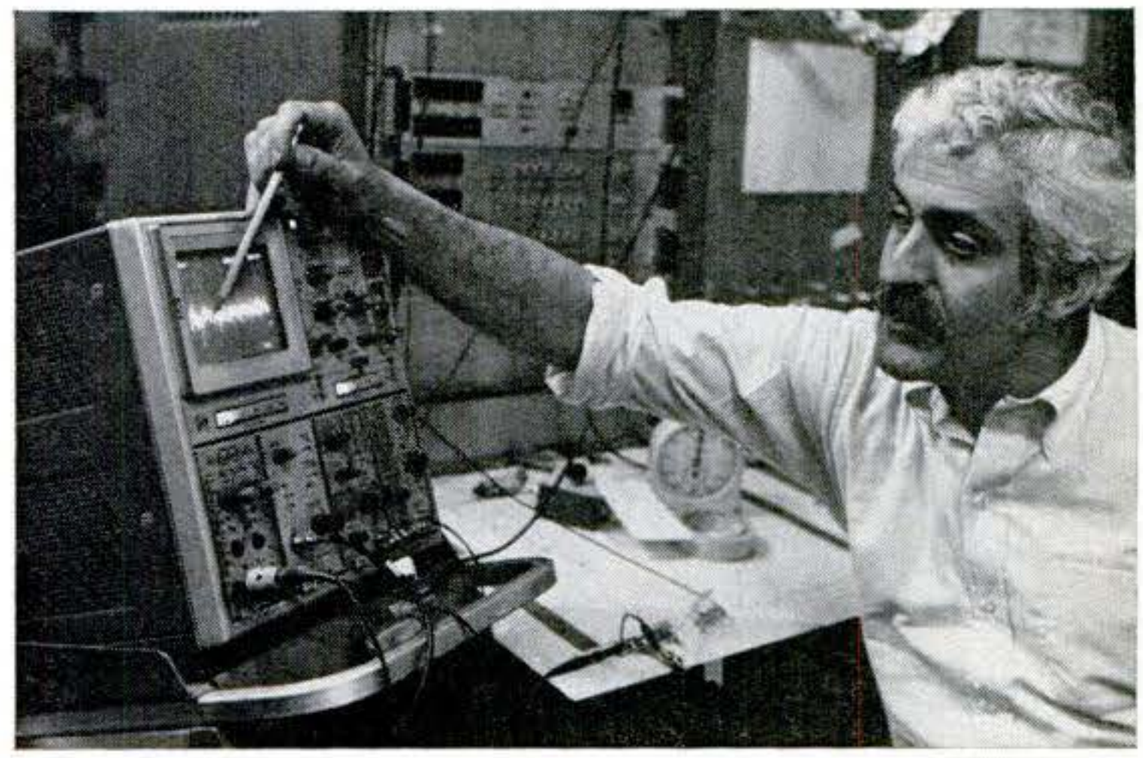

Damadian and his group design and build their own equipment, unlike most medical researchers. In the lab (left to right, top row), Damadian (left) and Minkoff discuss plans at the drafting table. Donning welding gear, Damadian prepares to fix a faulty seam in the magnet. Next, he uses the Kold Weld device to butt-weld the magnet windings. Framed by the giant RF coil that failed (lower row), Damadian and Goldsmith discuss the next step. With the magnet finally operating, Damadian monitors the oscilloscope and points to signals from a sample within the magnet.

strong signal it might be a tumor. To find out, Damadian can return the FONAR spot to that mass, and use traditional NMR to identify its chemical makeup.

The mouse picture Damadian showed me was the first evidence that this new process might be a cancer-detection tool. It showed a strong signal in the lung area—at the exact spot where a tumor had been surgically implanted in the mouse's chest wall.

Building a supermagnet

Once he'd used FONAR on the mouse, Damadian wanted to try the process on humans. For this, he needed a much larger and more complex magnet. After hours at the computer and the drafting board, Damadian produced a design for a superconducting magnet that met his requirements. It would have to be wound with incredible accuracy, and the windings would have to be connected without creating resistance-causing joints. To keep the liquid nitrogen and helium supercold, huge vacuum cans would have to be built and sealed tight.

But no commercial company made this kind of magnet. "So, we decided to build it ourselves," Damadian said. "It's been a monstrous task," he added as he circled around the giant magnet, pointing out its components. "If I had to do it over again, I wouldn't."

I asked if winding the magnet presented any problems. Damadian's associates, Dr. Michael Goldsmith and Michael Stanford, groaned. They had worked 16-hour days for five weeks winding the big magnet, they informed me.

The magnet took thirty miles of wire, so they also learned how to make superconducting joints between the leads. "This is a Kold Weld," Goldsmith told me as he lifted a small gadget from a shelf. "You simply butt the wire ends together and clamp them in this press. Niobium-titanium wire has a unique property—it forms a strong mechanical bond when crushed together."

Winding the magnet was just the first hurdle. To be superconducting, the magnet had to be cooled in a bath of liquid helium. Since helium at room temperature wants to be a gas, the crew had to build a giant sealed vessel to contain it. Called a Dewar, the vessel is actually a nest of three huge concentric donut-shaped cans. The liquid-helium can, with the magnet suspended in it, is surrounded by a can of liquid nitrogen that acts as insulation. A vacuum can encloses the two.

To stop heat leaks and to hold the vacuum, every seam in every can had to be carefully welded. Again, the researchers had to learn from scratch.

"My associate, Dr. Larry Minkoff, did most of the welding," said Damadian. Minkoff grinned at me. "I got help from the series you ran on welding" [PS, Oct., Nov., Dec. '76], he said. "But the industrial welding rod we used had too much thermal conductivity. When we cooled down the Dewar, the joints cooled too fast, and cracked. We had to weld them all again."

Even the metals used for the cans, however, were porous, and air kept seeping into the vacuum. Tracking down the leaks took four months.

[Continued on page 120]

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Solar ponds

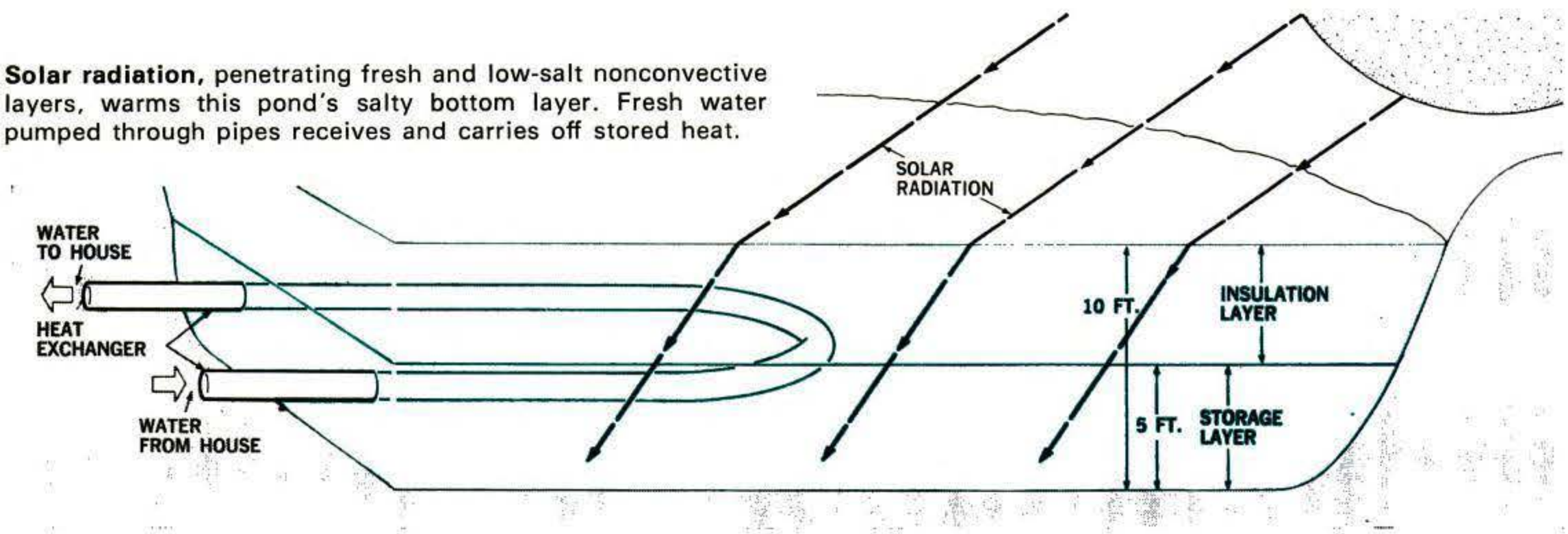
–heat from a hole in the ground

By ED NELSON

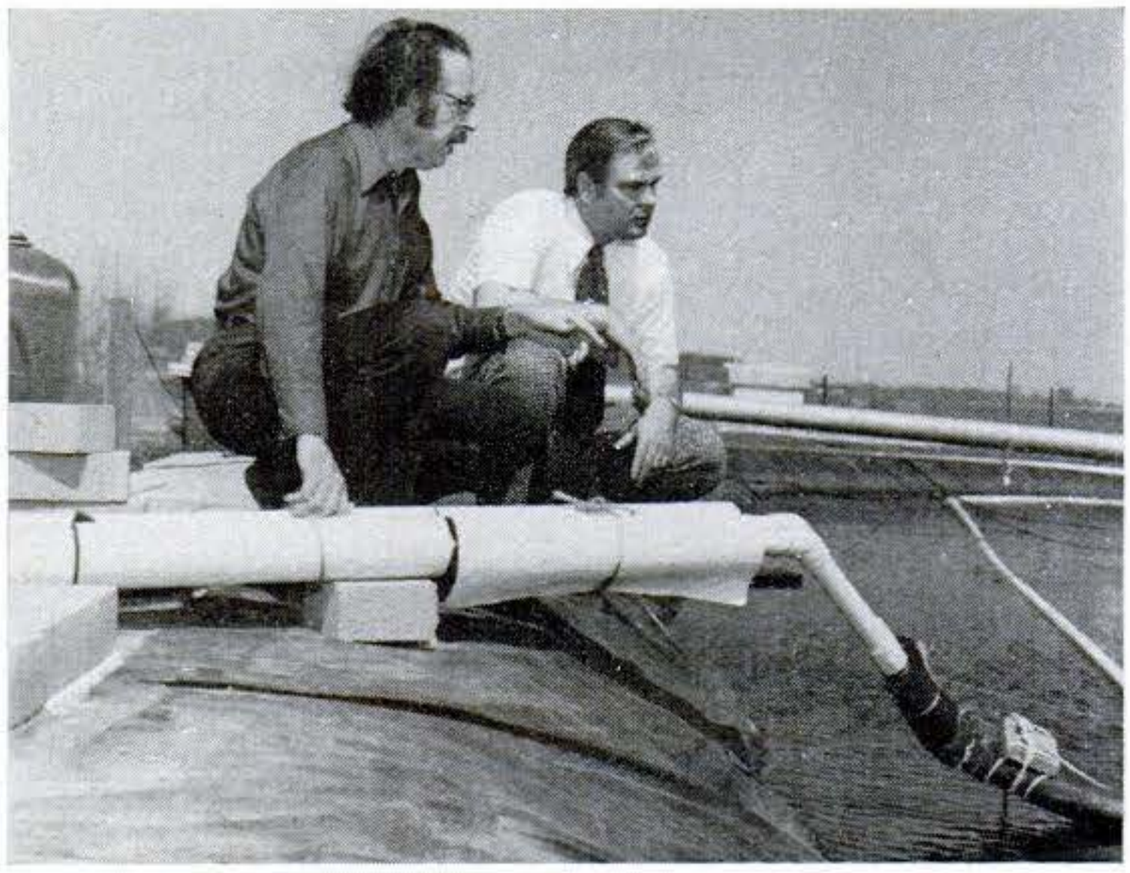
Ohio State University's Professor Carl Nielsen, a craggy-looking plasma and nuclear physicist, has a new solar-heating system near his office on the Columbus campus. It combines collection and storage in one medium, and is about as uncomplicated as you can get: a hole in the ground filled with salty water.

Salt distribution is the key. Ordinarily, ponds cannot act successfully as heat reservoirs because convection currents continuously mix water, bringing warm water to the top, where heat is wastefully dissipated to the air. But the unequal distribution of salt in Nielsen's pond—the salinity gradient—effectively damps convection currents.

Solar radiation, penetrating fresh and low-salt nonconvective layers, warms this pond's salty bottom layer. Fresh water pumped through pipes receives and carries off stored heat.



Photocells projecting from water surface are scanned by Prof. Carl Nielsen, on catwalk. Wire-mesh fence in background could keep wind-blown debris from blocking sun's rays.



Nielsen, left, with an assistant, attempts to determine losses from insulated, above-ground heat-exchanger lines. He thinks they won't be significant in actual installation.

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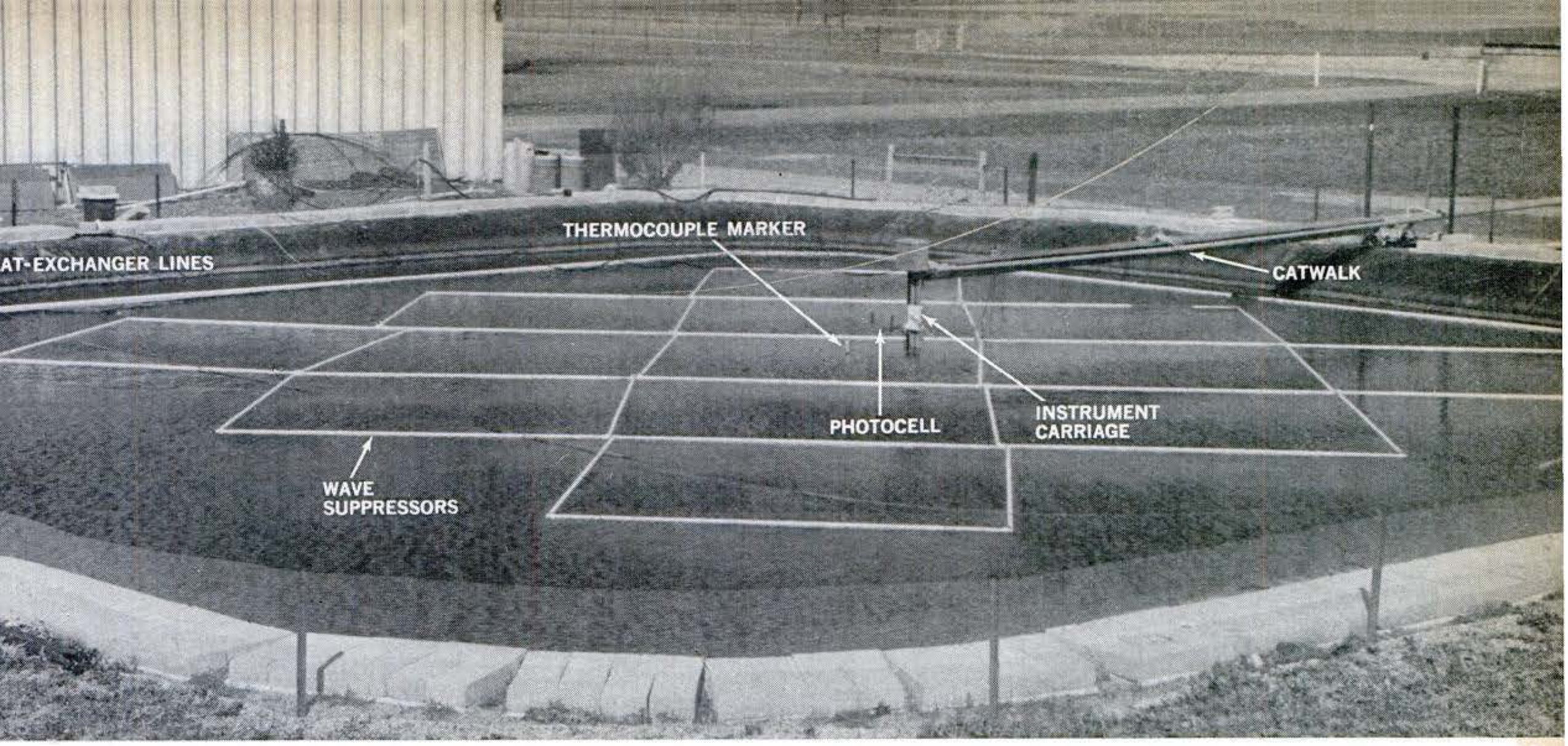

Lengths of floating plastic pipe were used on OSU's salt-gradient solar pond to suppress ripples that could cause mixing of fresh-water cap with saltier layers below. Catwalk gives access for study of instruments and occasional flushing of top. During system's first winter of operation, heat from the pond prevented freezeup in exposed shed at upper left.

How? The bottom half of the pond contains about 20 percent salt by weight. The concentration gradually decreases from the bottom up, until there is a thin cap of fresh water on top. Since each layer of water is heavier (because it is saltier) than the one above it, it resists moving upward even after it has been heated. Mixing of the layers is not, therefore, a significant problem, although about once a year the topmost layers need to be flushed out and salt added to the bottom.

The ability of still-water salt-gradient ponds to receive and store solar energy has been known for some time. Scientific measurements of salt lakes, made in Hungary and elsewhere in the 19th century, showed that temperature increases with depth and salt concentration. A decade ago, scientists in Israel (where salt from the Dead Sea is cheaply available) investigated solar-pond technology, but gave it up as an uneconomical way to produce electricity or process heat.

Professor Nielsen's 2100-square-foot pond is the first specifically designed to collect and store solar energy to heat buildings. And last winter, one of the coldest in Ohio's history, heat from the pond, fed into a simple car radiator, did prevent freezeups in a campus shed.

How does a salt pond store and give back the heat of the sun? The fresh and low-salt upper layers allow solar radiation to reach and heat the salt-saturated storage layer, then act as insulators to keep most of the heat from reradiating to the surface. Except for minor leakage, the heat keeps accumulating, until some is drawn off through heat-exchanger piping.

Nielsen calculates that his pond should ultimately be able to hold a full winter's heat for a Columbus-area house that has a floor area about equal to that of the pond's surface. "In winter months, when it isn't frozen," he says, "our pond will get 40 million Btu. In summer we'll get 70 million or so." He estimates that a reasonably well-insulated house with 2000 square feet needs about 100 million Btu of heat a year.

These expectations, however, are based on the assumption that solar input will raise bottom temperature to about 200° F by fall, and heat removal will cool it to about 100° F by spring.

Last year, in its first full season of operation, the pond's actual performance fell short of expectations because of biological and chemical problems, such as a heavy growth of algae, plus decaying oak and hickory leaves, that reduced radiation received at the bottom. An attempt to clear the murky water with copper sulfate led to further clouding (because of the slight alkalinity of water in the Columbus area). A little acid finally overcame the effects of these sun shields, but not before valuable testing—and heating—time was lost.

Better experimental data should be forthcoming this winter. And more of it, too, because a second pond has since been built by John Schuette, a Columbus building contractor. He also got a late start on his five-foot-deep, 25-by-75-foot pond, but he's convinced that he reduced his fuel bills last winter.

Drawing heat from a solar pond is uncomplicated: Nielsen suggests that convection tends to keep the warmest water near the top of the storage (bottom-most) layer, making this the best location for a heat exchanger: Water pumped through a long, horizontal loop of pipe picks up heat from the surrounding hot salt solution.

Single-home heating is ranked among the less-promising applications for solar-pond technology, which pleases Nielsen. He thinks farmers may be among the first to find pond economics attractive because they have the necessary unshaded space; after that, housing clusters, where groups of perhaps 10 homes might surround a single larger pond.

Considering the rising costs of other forms of energy, the OSU professor thinks that practical applications of pond-stored solar energy may not be far off. PS

John Schuette, first man to build a solar pond at home, checks salinity in his makeshift brine mixer before admitting progressively less-salty water layers.

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What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

First U.S.-made FWD minicar

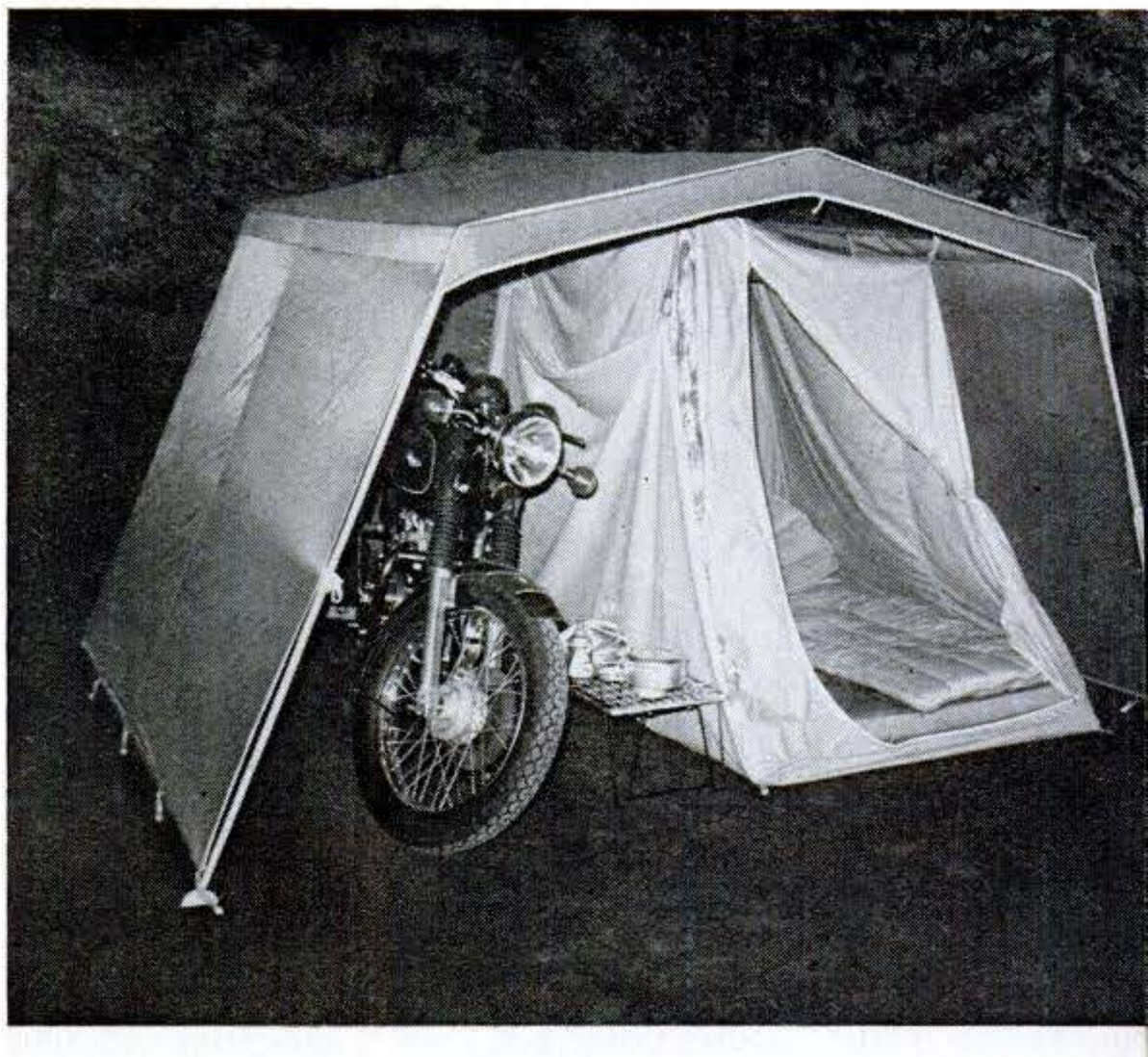
Dodge Omni is the first front-wheel-drive subcompact ever built in the U.S. Nine inches longer and 250 pounds heavier than the VW Rabbit, it has a 1.7-liter, four-cylinder engine with Chrysler's Electronic Lean Burn emission system. There are three interior trim grades. Automatic transmission and air conditioning are optional. Mileage and price will be competitive with Fiesta and Rabbit: about 34 mpg (combined highway/city) and a base price of about $3700. Deliveries of the Omni and its twin—Plymouth Horizon—start next month.

Plastic can

Toss this plastic can in the incinerator and there's no pollution, says Akerlund & Rausin, its Swedish maker. The polypropylene container leaves only harmless carbon compounds when burned. Its rectangular shape saves space, and the pull-open lid won't cut fingers.

Radar detector

An alarm sounds and lights flash when GTE Sylvania's RWR-1000 detects antipersonnel radar. The portable device warns troops before enemy radar detects them. Details about signals—direction, frequency, pulse interval—appear on a display.



Bike tent

Campers can give their motor bikes nighttime cover with this dual-role tent. It covers an eight-by-seven-foot area, folds into a 24-inch-long, 20-pound bundle. Binleys Camping Center (Kettering) Ltd., Victoria St., Kettering, Northants, England.

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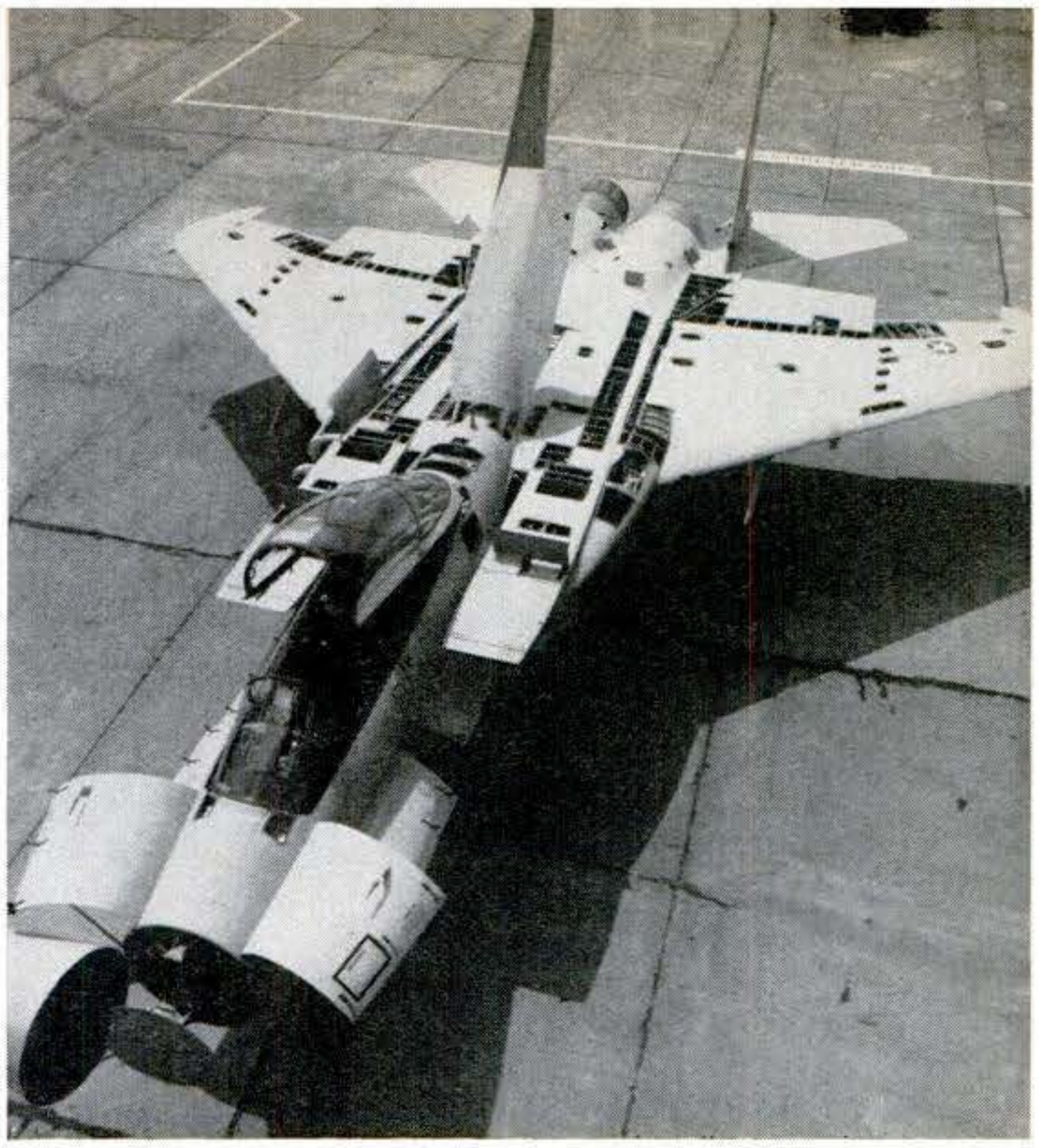
Super fire truck

Two 430-hp diesel engines accelerate this super-size airport crash/rescue truck to 50 mph in 35 seconds. The 66-ton trucks, made by Oshkosh Truck Corp., Oshkosh, Wis., have tanks holding up to 6000 gallons and can pump 2500 gallons a minute.



Easy-access F-15

Like ruffled feathers, access covers on McDonnell Douglas Corp.'s F-15 Eagle open for maintenance access. The 185 access doors and panels cover 570 sq. ft., to make maintenance work faster and simpler. Most F-15 systems can be reached without a stepladder.

Water heater

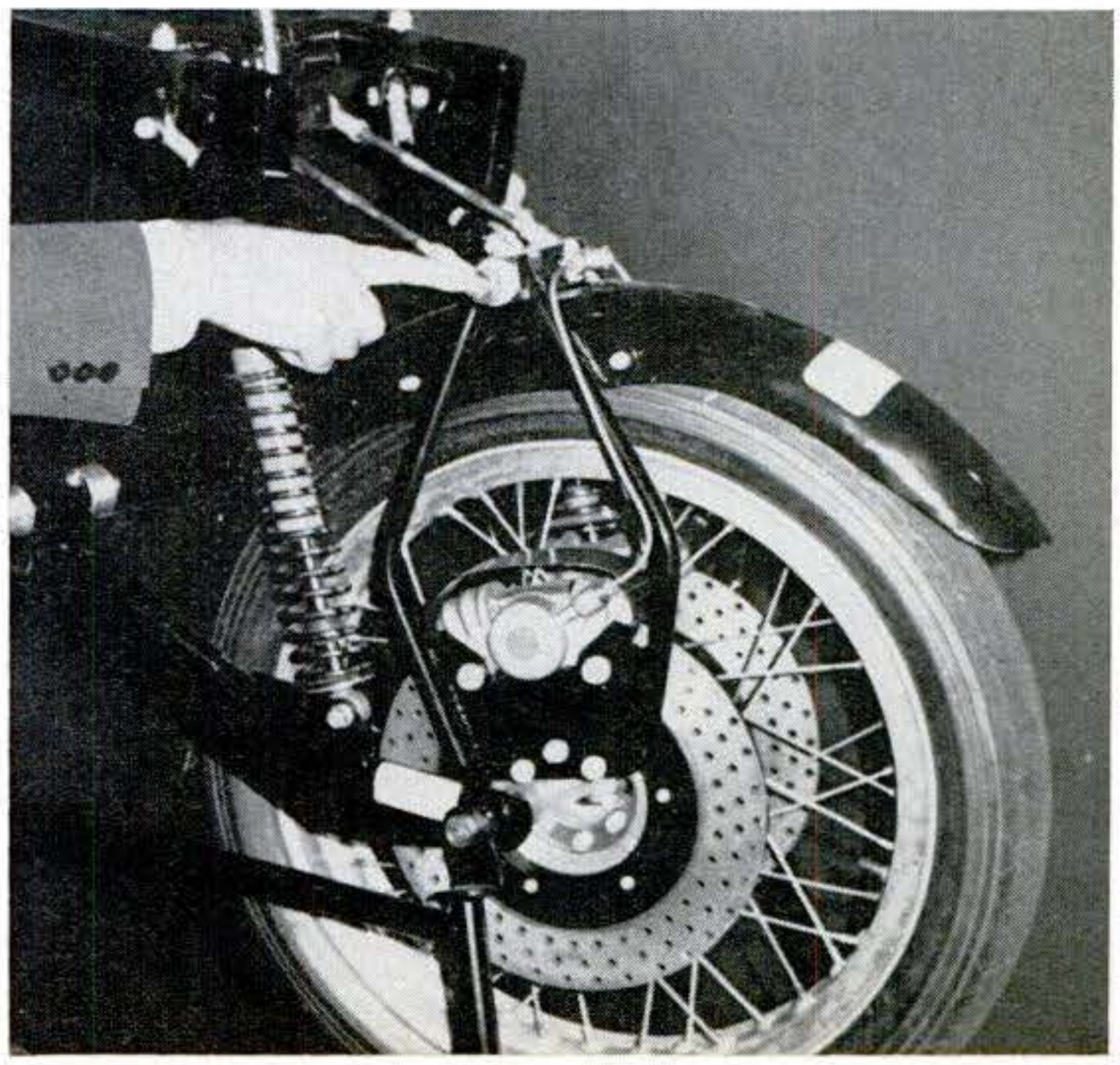
Fill the Solar Wunder with water or beverages and let the sun heat the liquid. Water reaches 120° F in one to two hours, or boils with extended exposure. Capacity: two gallons. Solar Works, Inc., 4817 1st Ave. S., Birmingham, Ala. 35222.

Digital rope

Jump rope or jogging? Ten minutes with a rope equals 30 minutes of jogging, says Dynamic Classics, Ltd. Its new jump rope has a digital counter to record your progress. Ball-bearing handles keep the rope tangle-free. The Digital Jump Rope is $9.95 in stores.

Anti-dazzle device

Bright lights often black out closed-circuit surveillance TV cameras. But an electronic Eclipser, plugged in between camera and monitor, converts light peaks to black spots (above), enabling cameras to adjust. Power-Optics, Fairview Village, Pa. 19409.



Bike steering

This hub-steering mechanism for big motorcycles eliminates the usual front-fork/handlebar design and makes large wraparound windshields possible. The hub pivots on a spindle carried on coil-sprung suspension arms. Difasio Motorcycles, Frome, Somerset, England.

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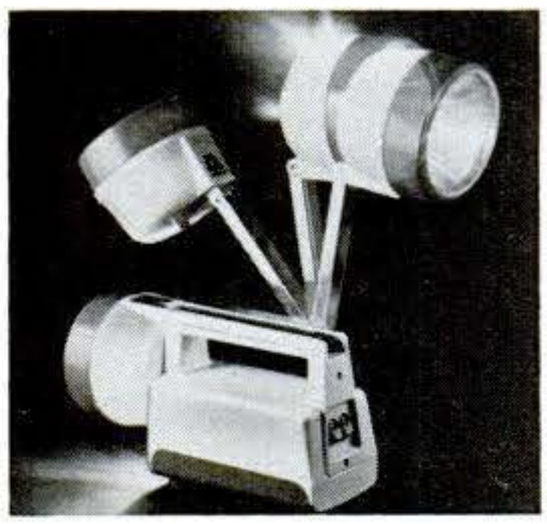
What's New

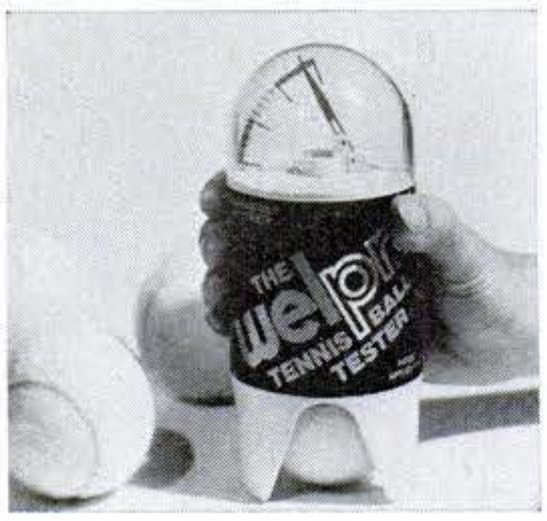


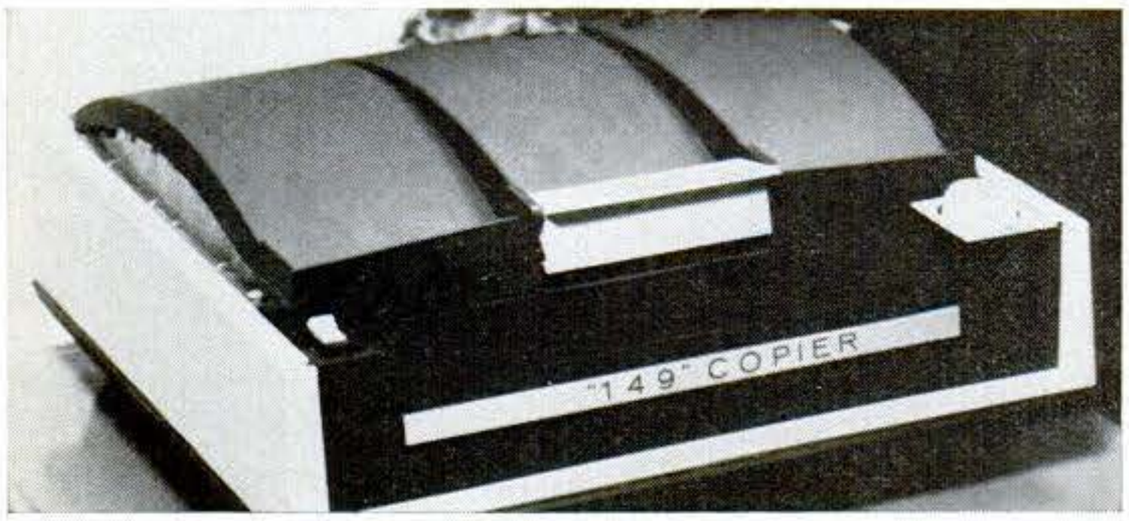
Swivel light

You can shed light on any subject with the Angle Beam six-volt lantern. Its 180-degree swivel head is mounted on a movable extension arm. A separate switch converts the searchlight to an emergency flasher. $10. Ashflash Corp., 1151 Woodward Ave., S. Norwalk, Conn. 06856.

Computer guide for tourists

An electronic route-finder gives precise directions to travelers in Hamburg, Germany. Punching out a code number for your destination actuates a microprocessor. This plots the most direct route via the city's public transport system, which includes subways, buses, streetcars, ferries, and suburban trains. The computer then delivers a guide sheet that shows the best route and notes schedules, interchanges, and fares. A similar machine at the main rail station in Munich plots train routes to 300 European cities. The printout shown here gives the Munich-London route.



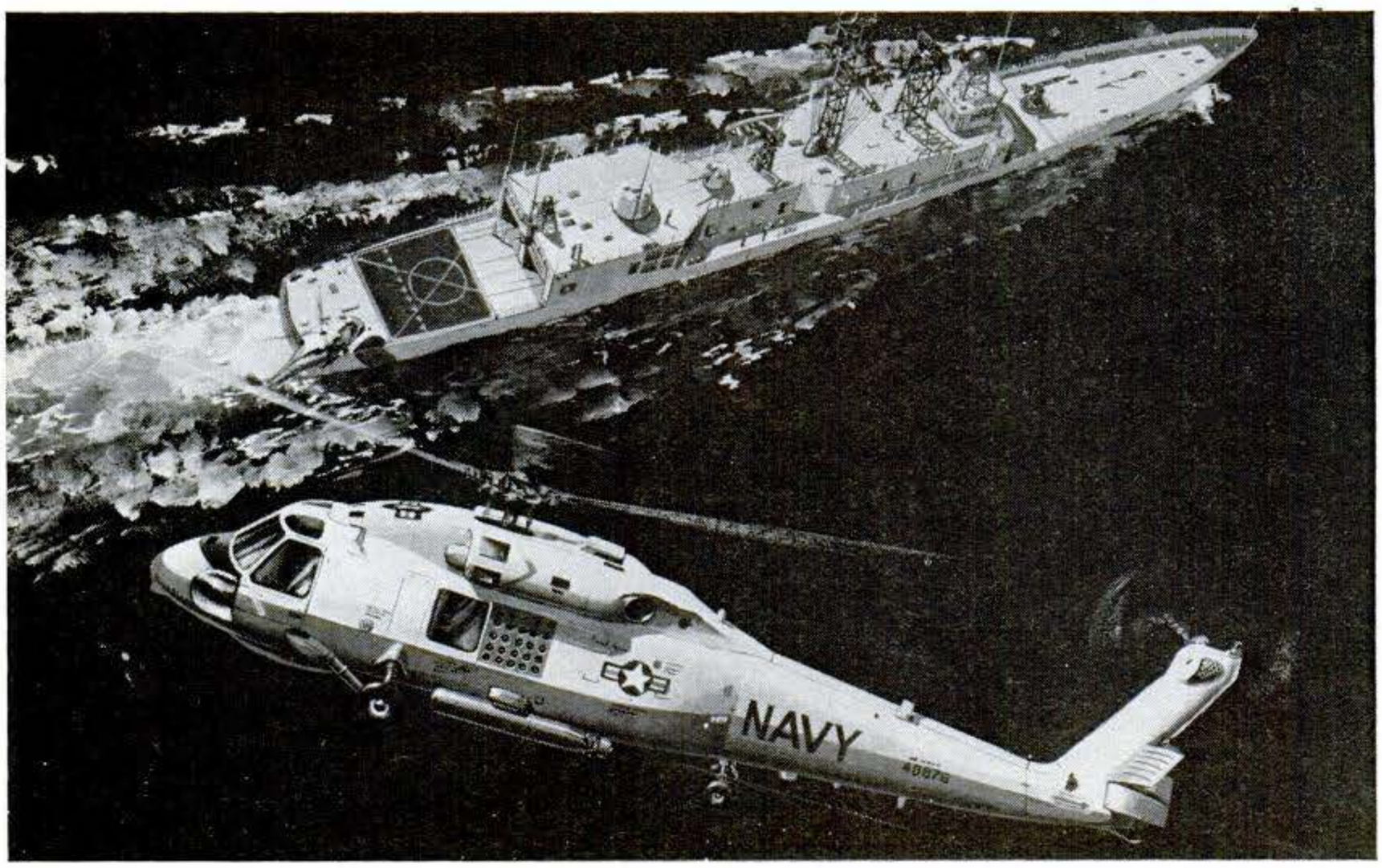


Convenient copier

No more stealing time to copy personal papers on your office machine—3M's desktop home copier works off 120V current, weighs six lbs. It needs no chemicals, but the two-step process does require 3M's heat-sensitive paper. Copies cost less than 12¢; model 149 is $100.

Pressure tester

Efficiency-minded players can quickly sort a pile of balls with the Tennis Ball Tester. Push it down on a ball and the scale shows the ball's pressure, indicating whether it's good, usable for practice only, or dead. It's $11. Welpro, Box 1837, South Bend, Ind. 46634.



Multi-purpose sea-going copter

A versatile helicopter, Sikorsky Aircraft's new LAMPS (light airborne multi-purpose system) copter was developed as a transport for the U.S. Army. Modified for Navy use, the chopper will carry avionics and weapons needed for antisubmarine and anti-cruise-missile warfare. It can also be used for search-and-rescue missions and medical evacuations. The twin-turbine-powered chopper has a four-bladed, titanium-and-fiberglass rotor 53 ft. 8 in. across. Its graphite-composite tail rotor is 11 ft. across.

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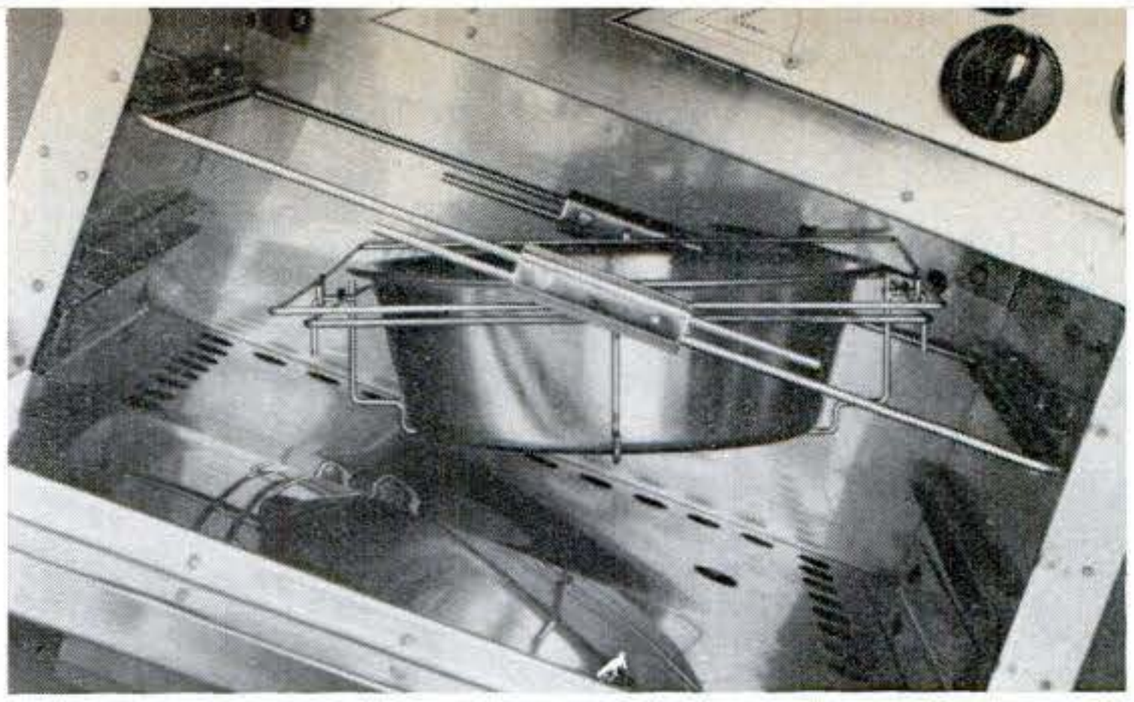
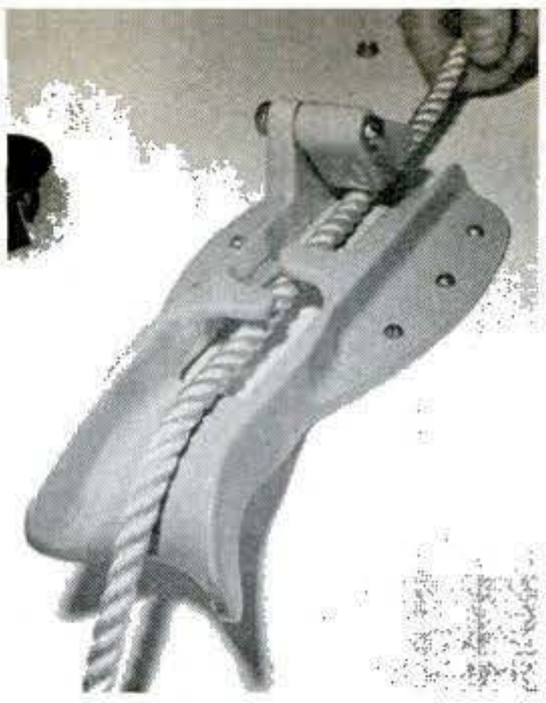
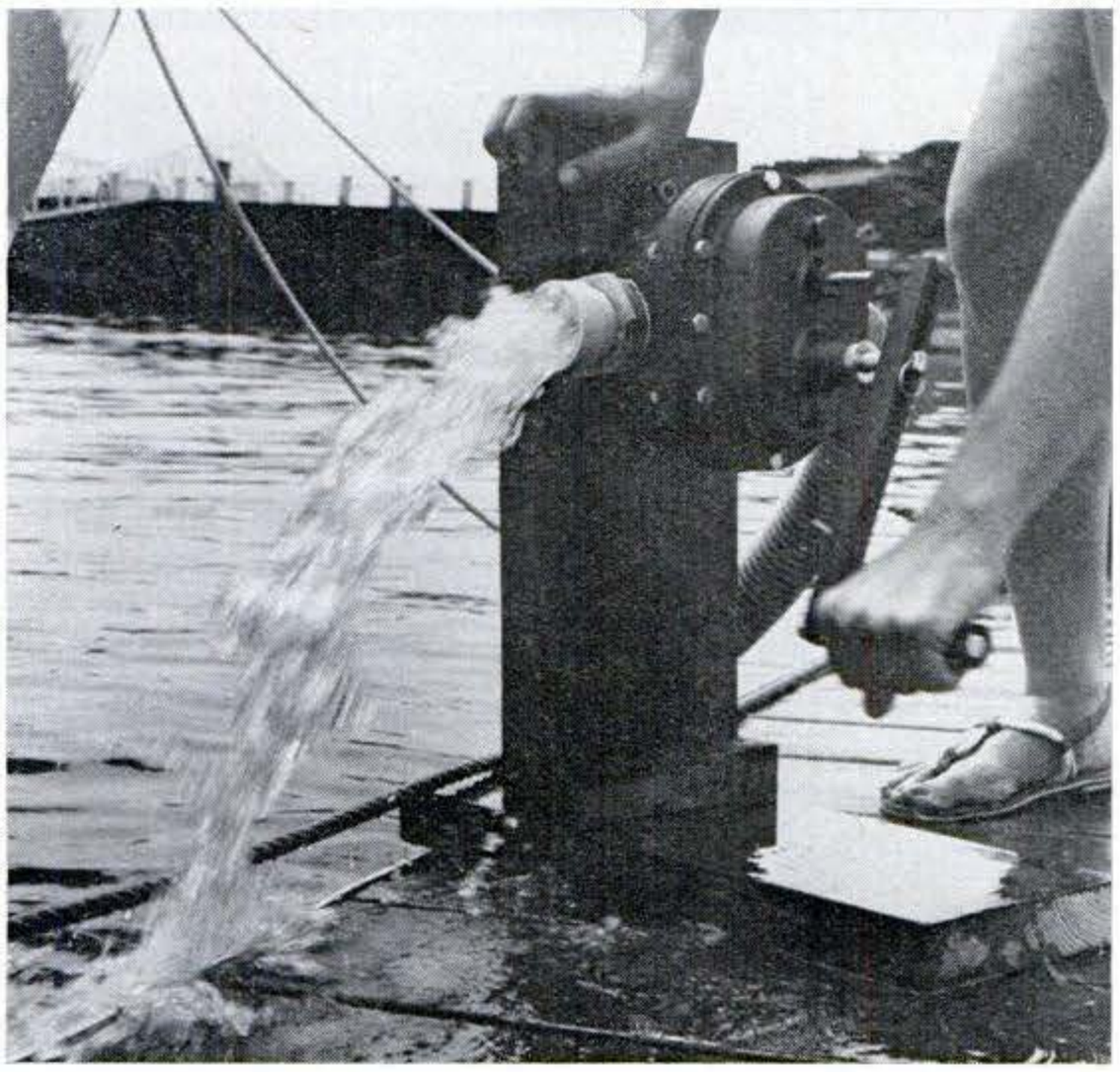
What's New IN BOATING

BY SUSAN RENNER-SMITH







Pan leveler

Galley slaves can cut down on clean-up time with Cruisin' Culinary. The chrome oven rack has a 360° gimbals assembly for spill-proof cooking. Fits 12"-by-12" ovens; adjusts to 22" wide. Rack and two pans are $31.15 from Multi-Mart, Box 8033, Redwood, City, Calif.

Remote hoist

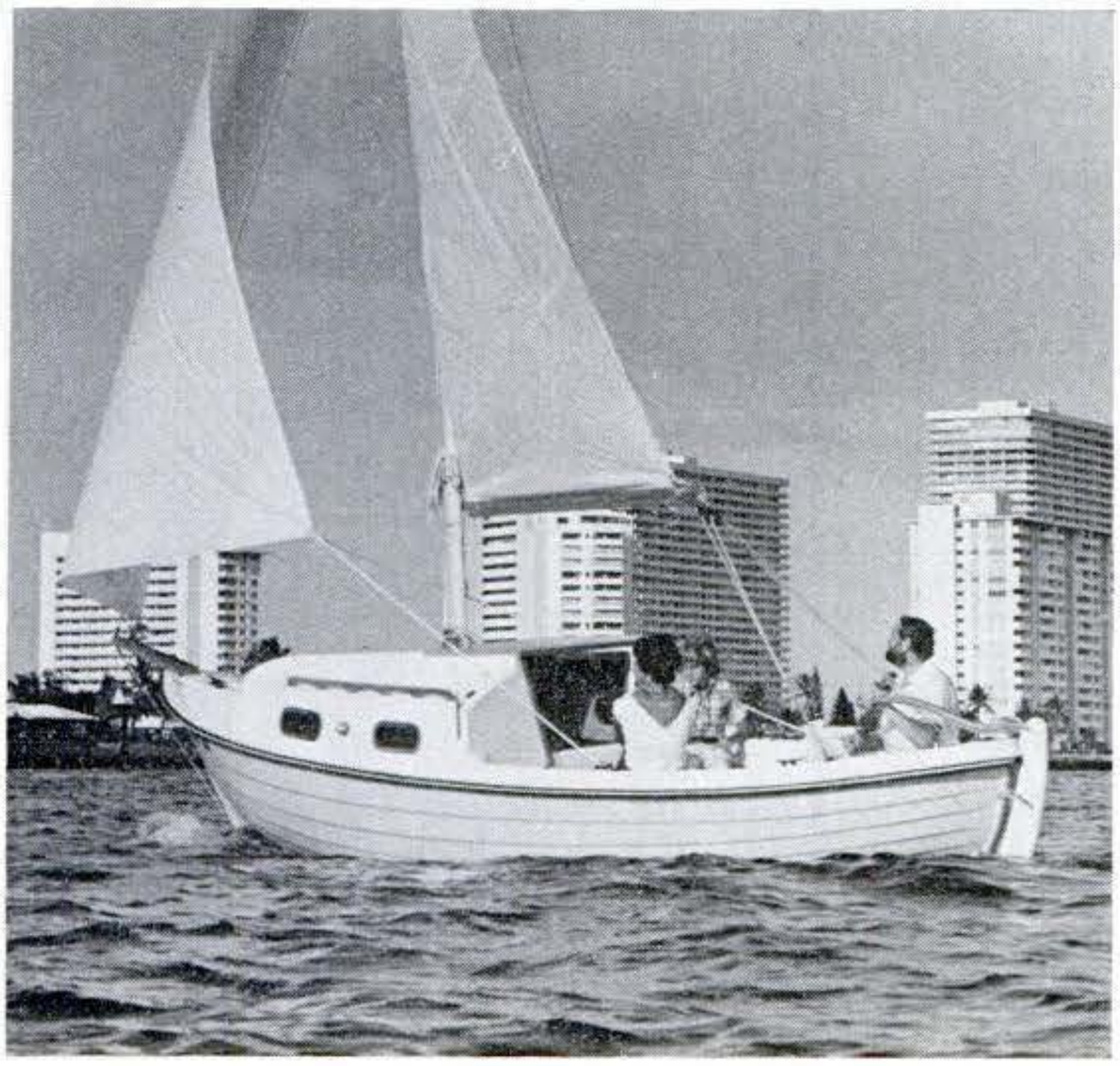
Want to raise anchor without rising? Tug on the rope and Anchor Hoist's contoured base guides the line into a toothed cam that locks it in place. Ready to drop anchor? A sharp pull on the rope releases it. Price: $7.50. Bremer Co., Box 100, Elkhart Lake, Wis. 53020.

Rotary bilge pump

"Easily pumps 40 to 50 gpm," reports a PS staff member after testing the GP-5 positive-displacement pump. The unit tested needed priming, but newer models are self-priming up to five ft., with a two-in. suction hose. The pump has an anodized, cast-aluminum housing; stainless-steel shafts, impellers, and gears; and self-lubricating bearings. The rotary crank makes hand-pumping easy. Or you can power it with a ¼-hp electric drill. With power, the pump delivers about 110 gpm, says Assoc. Marketing, Box 816, Upland, Calif. 91786. Price: $250.

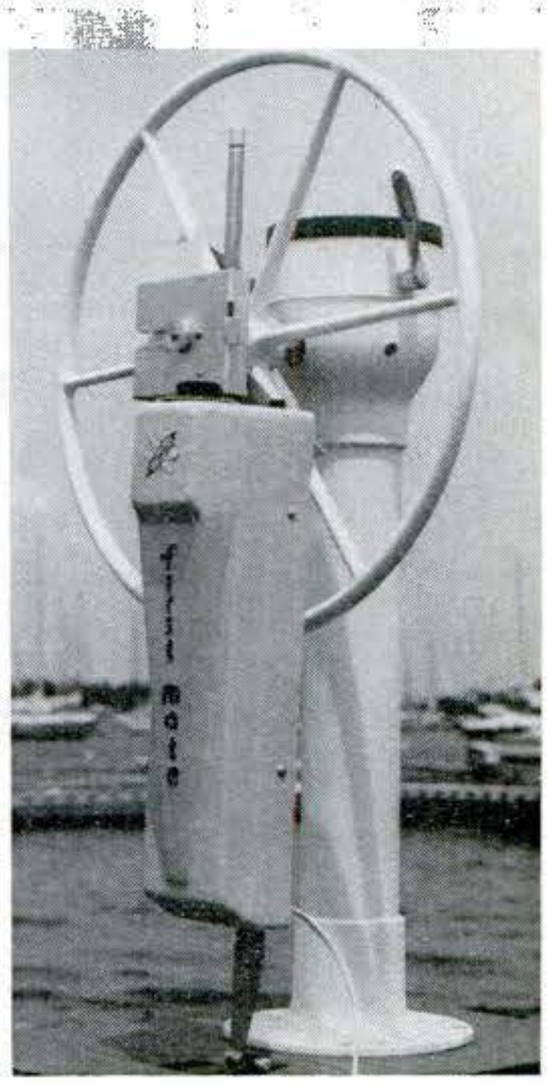
Lifeline

Hurl the reusable Emergency Life Line and it pays out 131 ft. of floating plastic line. The plastic container will fly 75 ft. and has built-in buoyancy. You can repack the line in about 10 minutes, says the maker (Balcan Ltd., 41 Witham Rd., Woodhall Spa, Lincolnshire, England).



Sturdy sailer with a classic air

Inspired by North Sea fishing boats, the Skipper 20's hull has the look of planking, but is constructed of sturdy fiberglass. Teak trim adds to the seaworthy look, as do the bowsprit, laminated wood tiller, and oval ports—all standard equipment. Six-ft.-long cockpit seats make for comfortable day-sailing; at night, the cabin sleeps four adults. A small stowage compartment in the stern accepts a small inboard or can be fitted with an outboard motor well. The 20-ft. double-ender is $5000 from Southern Sails, Inc., 12480-44 St. N., Clearwater, Fla. 33520.



Autopilot

Compact and portable, the 12-lb. VT-7 autopilot mounts to the wheel with one nut. Linear motion from the vertical steel tube drives a sprocket to turn the wheel. The VT-7 works for sailboats to 45 ft. Electro-Mechanical Prod., Box 330778, Miami, Fla. 33133. $649.

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What's New
IN TOOLS

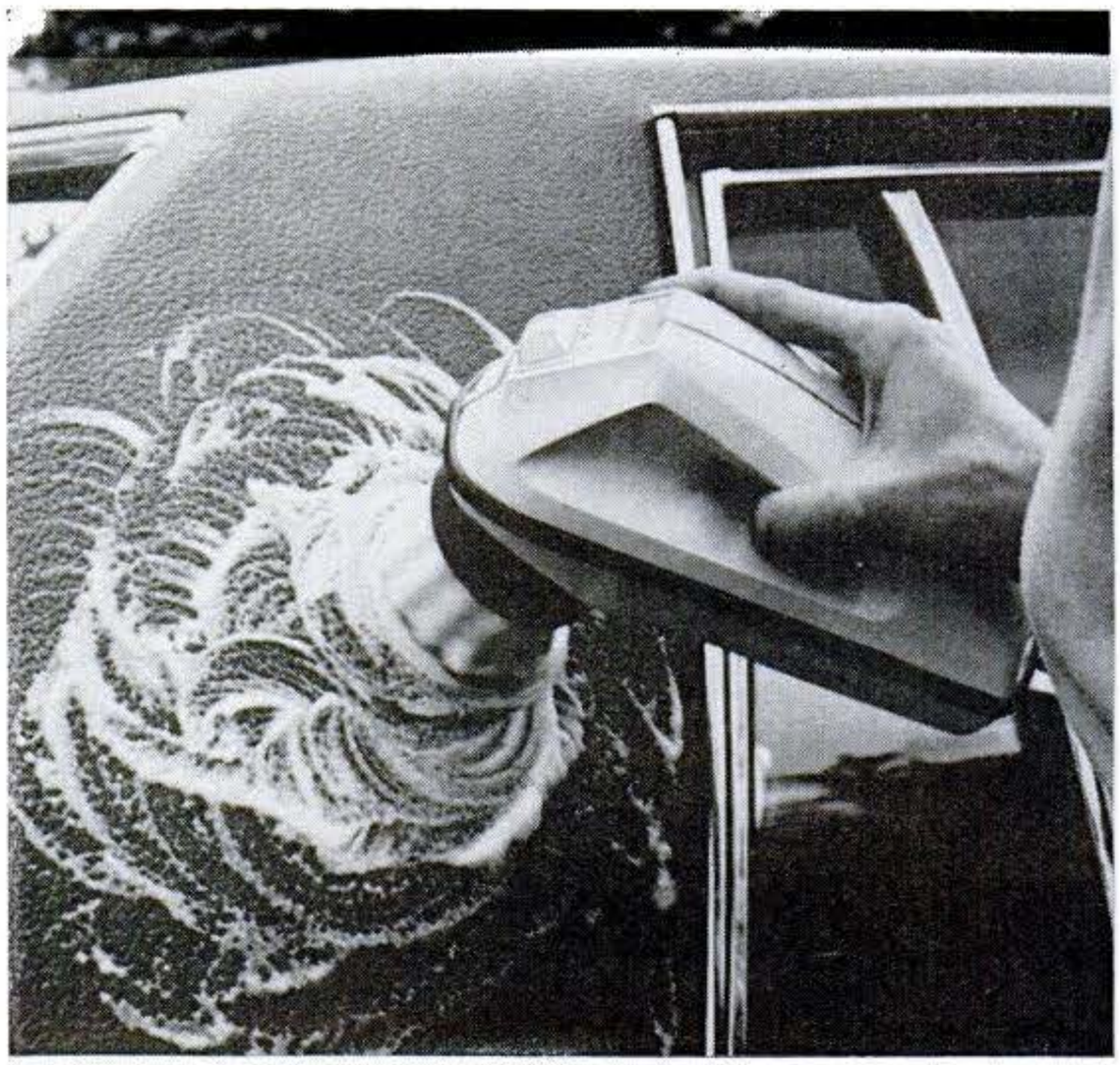
BY R. L. STEPLER

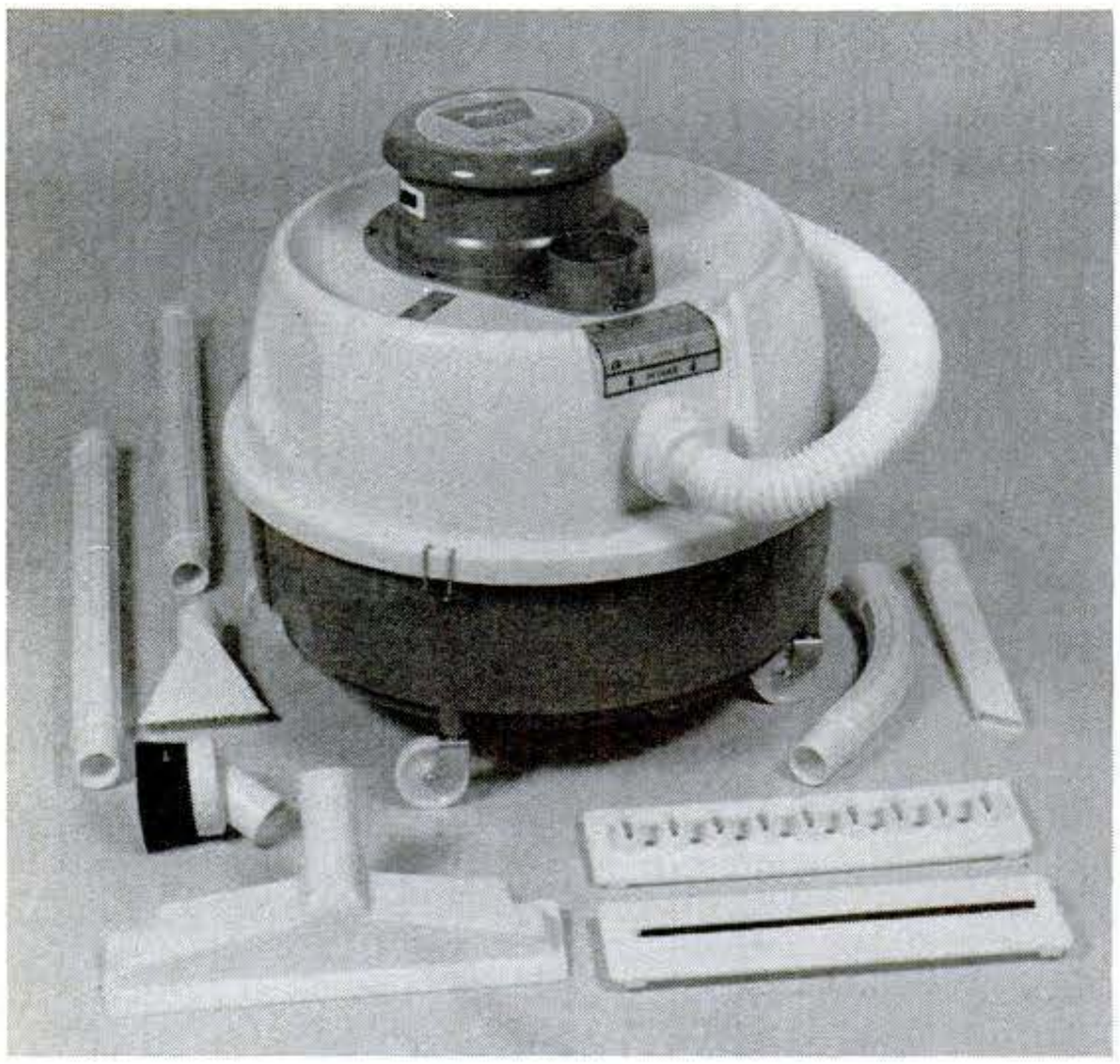
Drill bit

Longer step configuration in 6Bit let you drill 3/16", ¼", 5/16", ⅜", 7/16", or ½" holes in wood, plastic, or sheet metal up to ⅜" thick. The $7.95 bit fits ¼" drills. It's by Unibit Corp., 102 S. Academy St., Wyoming, N.Y. 14591.

Accessories for socket wrenches

The Gripall socket (left) adjusts to fit hexagonal bolts and nuts from ⅜" (10 mm) to 1-⅛" (29 mm). The stainless-steel tool fits standard ½" (13 mm) square ratchet-socket drive handles. Price: $25. If that bolt or nut's in a cramped spot, the Flex extension (right) can provide easier access. This 8"-long device consists of connected steel flex joints with a protective outer shield. It's designed for conventional ratchet-socket or air-impact wrenches with ⅜" (10 mm) or ½" square drives. Price: $17. Williamson, 519 Garfield Dr., Cherry Hill, N.J. 08003.





Shop vac

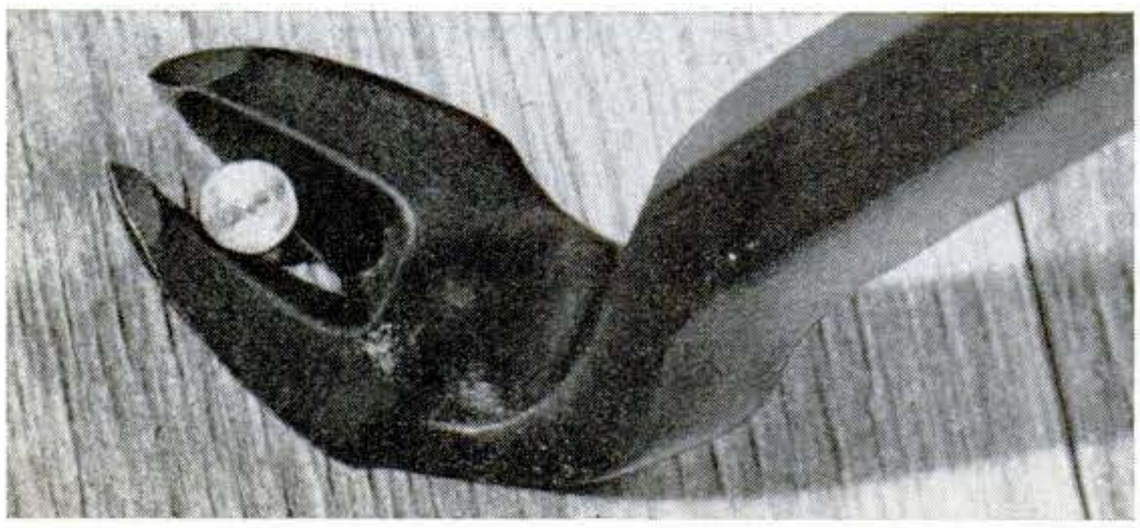
Made of polystyrene and ABS, Maxi-Vac holds eight gallons dry or 3½ gallons wet. A 1.1-hp motor powers the rig, which rolls on four casters. Price of the model 6012, including accessories shown, is $50. Maxi-Vac, Box 482, Palatine, Ill. 60067.

Scrubber

Put power into your scrubbing chores with Disston's Scrubber. A rechargeable Powerpack, which fits six other Disston tools, provides the power. The tool comes with six brushes, sponge, and scouring pad. Price: with Powerpack, $40; without, $24.

Shadow finder

Finding a shadow-free site for solar collectors should be easy with the Shadow Mapper. The device lets you track the sun's path throughout the year. Any object visible in the sight tube will cast a shadow at that location. $367. Campbell Engineering, 1302 Toney Dr., Huntsville, Ala. 35802.



Nail pullers

Stanley says its new ⅝" hex steel nail pullers have larger claws to ease extraction of imbedded nails. Model 55-040 has 90° offset claw at one end, ripping chisel on other, costs $4.73. Model 55-035 has 30° and 90° offset claws, costs $4.99.

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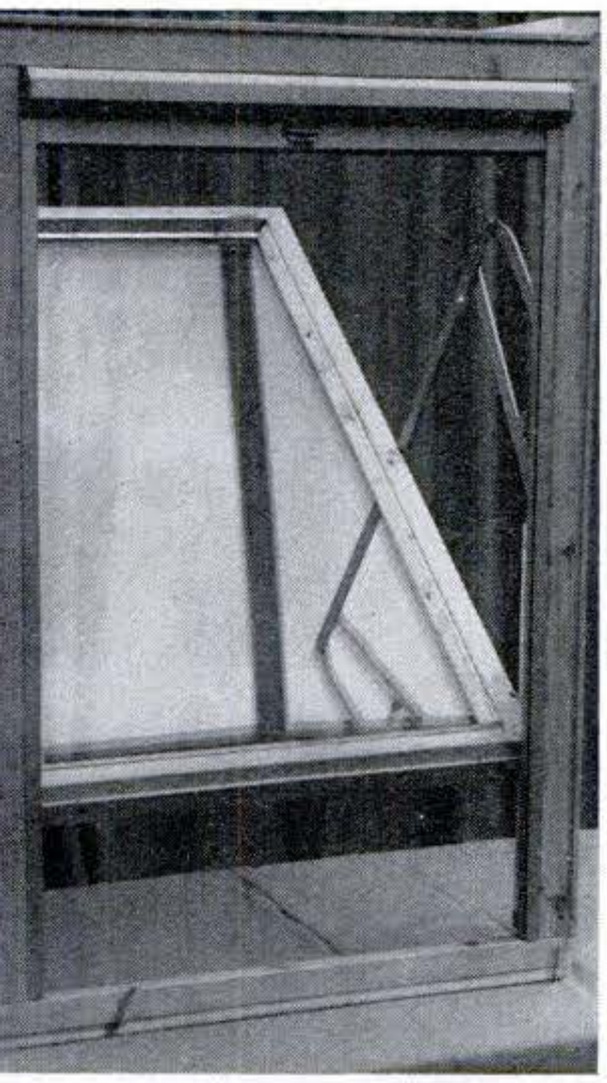
What's New IN HOME IMPROVEMENT

BY R. L. STEPLER

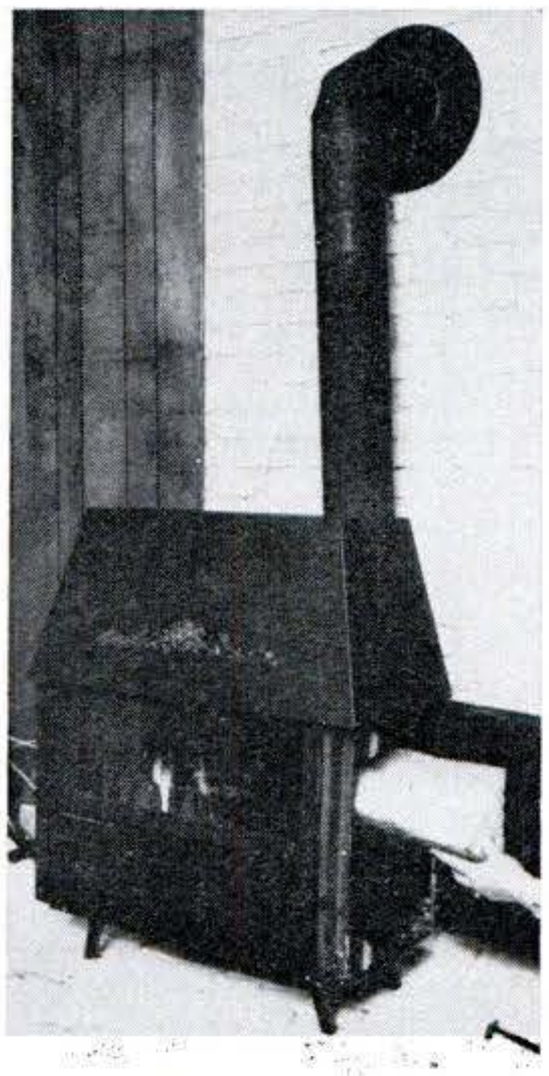


Pivoting window

Weather stripping on all four sides makes the H-Window exceptionally air- and water-tight, the maker claims. It opens outward and pivots 180° so you can wash windows from the inside. Norse Designs, 4634 164th Ave. S.E., Issaquah, Wash. 98027.

Wood stove 1

Watch the flames dance behind HotBox's screen—or fit the solid steel door in place and use it as an airtight stove. HotBox is made from 3/16" steel, measures 30" wide, 28" high, 20" deep. It's $295. Boston Design Corp., 183 W. Canton St., Boston 02116.



Wood stove 2

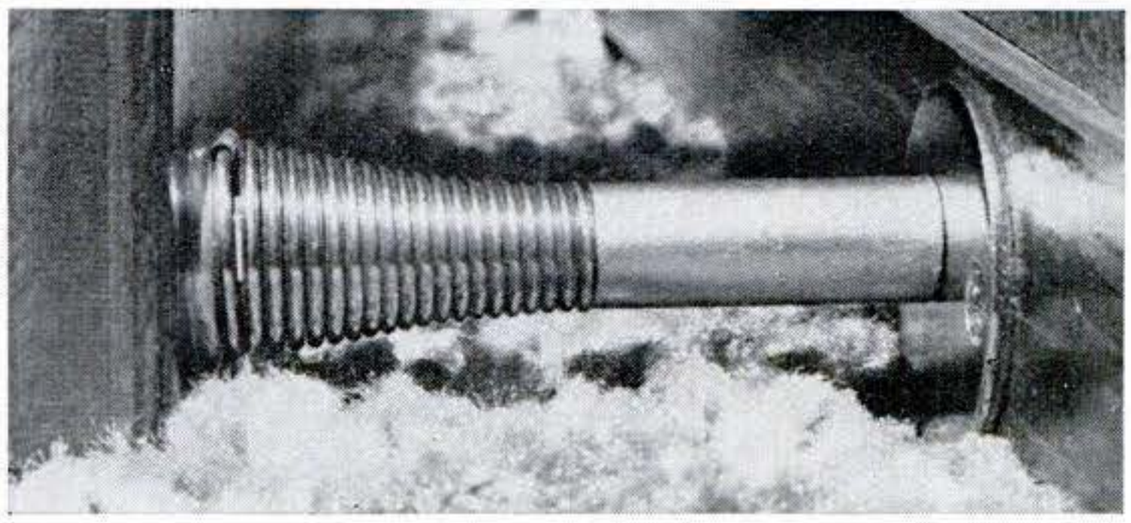
View the fire thorugh the Pyrex glass door of the Belgian-made Efel—or fold the door for an open fireplace. The airtight end-loader burns wood or coal, has a grill for barbecuing. Price: $495. Southport Stoves, 248 Tolland St., East Hartford, Conn. 06108.

Water saver

The strong, tingling spray is still there, says the maker, but water flow of this shower head is only three gallons per minute, compared with conventional shower heads' seven to 16 gpm. Price: $5.75. Water Saving Co., 1641 Third Ave., New York, N.Y. 10028.

Wallboard

Foil-back Sheetrock has a built-in vapor barrier: Kraft-backed aluminum foil is bonded to the back of the panel. That's to keep moisture inside the house spaces, and out of stud and joist spaces, says U.S. Gypsum (101 S. Wacker Dr., Chicago, Ill. 60606).



Doorstop

What's holding the door open? It's an Alnico #5 permanent magnet with three pounds of holding power. A steel spring protects against damage. Price: $3.98. Maker: Magnetic Door Stop and Holder Co., 2404 38th Ave., Sacramento, Calif. 95822.

Clear plumbing

Replace the clean-out plug in your plumbing with Clearviewer for quick detection of water-system ailments. Add an aerator to build up bacteria in septic tank. Clearviewer: $40; with aerator: $100. From Plumber's Eye, Inc., River Rd., Marcy, N.Y. 13403.

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What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS

Mini AM/FM/TV

Sling this eight-lb. portable over your shoulder and you have it all—AM/FM music plus a 4½-in.-diagonal black-and-white TV. Model 521R from Webcor (Div. Leisurecraft Prod., Plainview, N.Y.) runs on eight D cells. Antenna is built in; car adaptor optional. $200.

Car finder

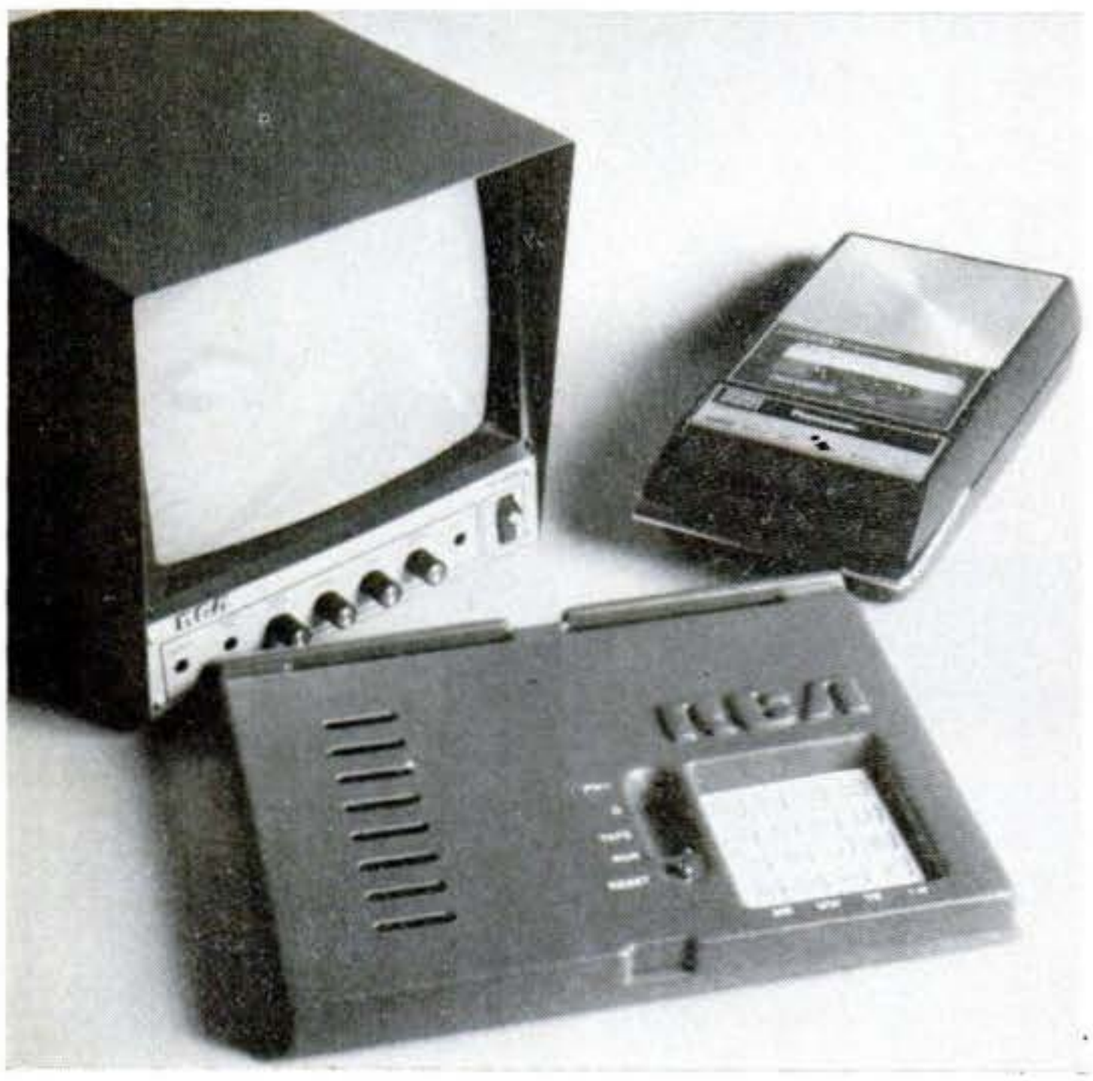
Push the button on the pocket transmitter (left), and the remote receiver in your car blinks the headlights or blows the horn—so you can instantly locate your car in a large lot. It's $59.95 from Tran Sonic, 12 Farview Terrace, Paramus, N.J. 07652.

Digital scale

Step up and be counted—to within two-tenths of a pound—on this new Heath bathroom scale. A battery-powered electronic circuit measures and displays your weight in LED readouts. It's $99.95 in kit form from Heath Co., Benton Harbor, Mich. 49022.

Volt tester

Troubleshoot AC wiring with Mono-Probe—only one connection is necessary to detect 120, 240, or 480 VAC. An audible alarm and indicator checks switches, plugs, breakers. $39.95. Mono-Probe Corp., 5471 Huntington Dr., Los Angeles, Calif. 90032.



Home computer

Want to learn about home computers? You can—by building one yourself. RCA makes it easier with its COSMAC VIP kit. Built-in programs and an instruction manual can teach you programming in one evening. Tape recorder and video display are optional. $275.

See-through mike

Looking for a clear advantage over other CB'ers when you transmit? Use a noise-cancelling power mike—and this one from Telex can't get much clearer. Its see-through plastic case makes it a true conversation piece in more ways than one. The Clear Case is $42.95.

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What's New
FOR YOUR CAR

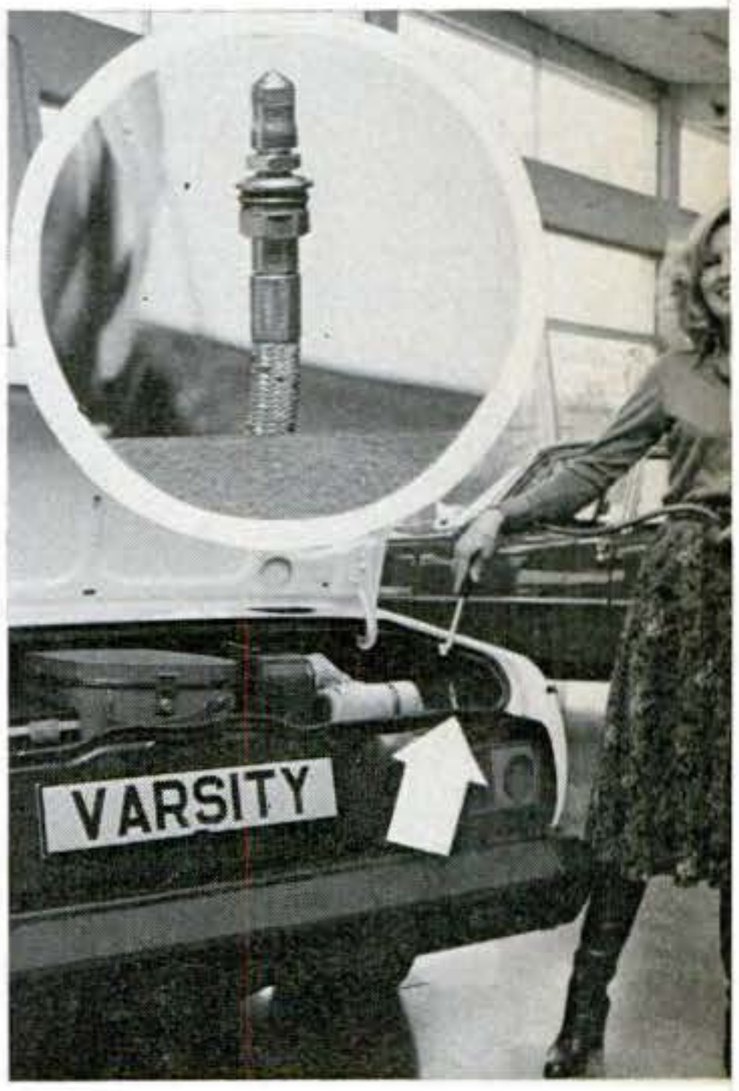
BY RICH CEPPOS

Engine lift

An adjustable engine lift makes installing or removing any American V-type engine a one-man job, claims J&J Mfg. Co., Box 5265, Lincoln, Neb. 68505. The unit bolts on in place of the carb; a hook from a block and tackle slips through the loop to lift the engine. Price: $39.95.

All-season tire

You'll never need to change over to snow tires if you use Goodyear's new Tiempo all-season tires, says the maker. The Tiempo outperforms most radial winter tires on ice and snow, Goodyear claims, yet has the quietness and handling of its Polysteel radial in dry conditions.



Reading lamp

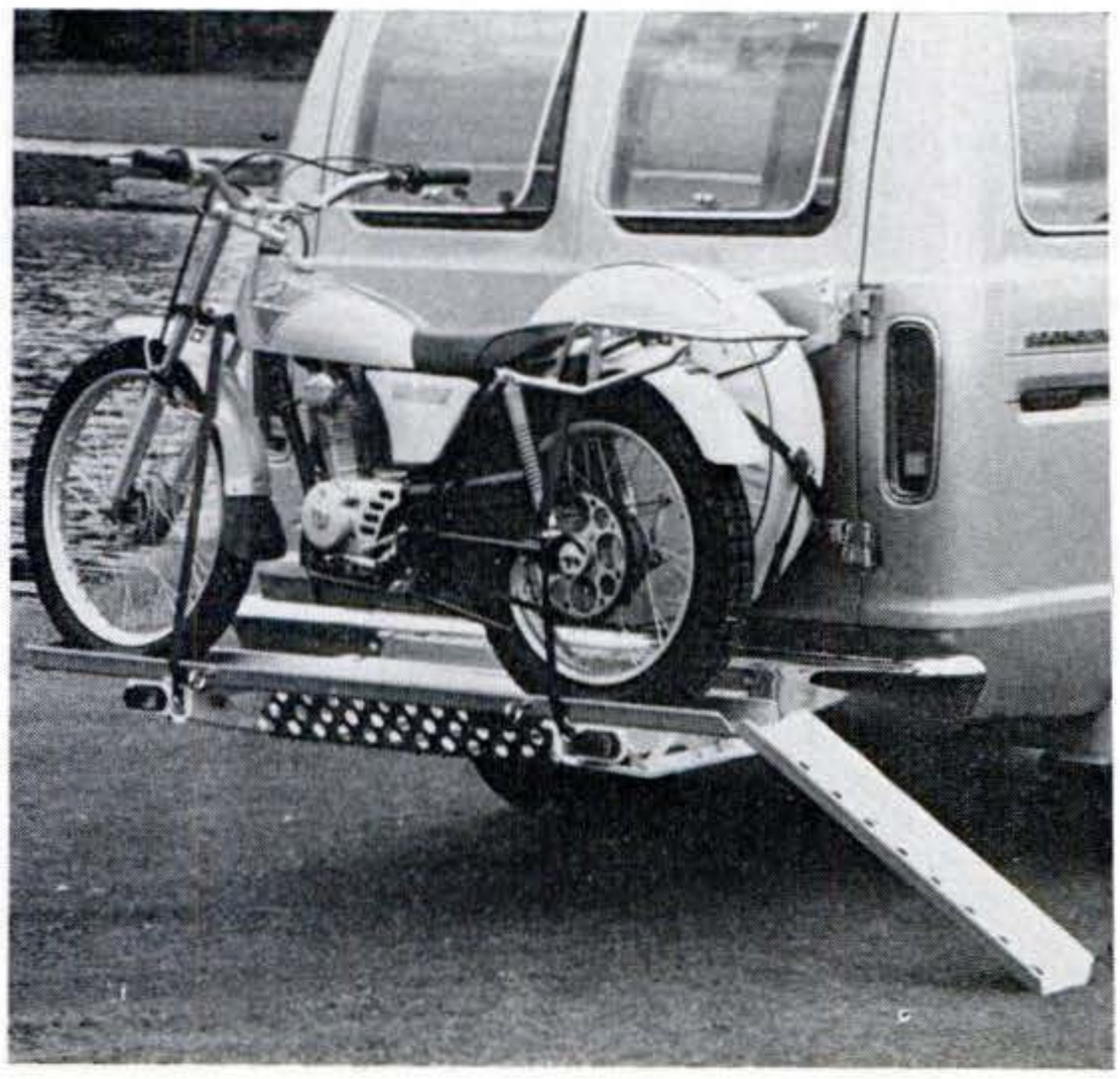
Map reading is easier with this flexible British interior lamp. The intensity level is adjustable, and the flexible brass tube fits almost anywhere in your car's interior. Brown and Geeson Ltd., Selinas Lane, Dagenham, Essex RM8 1EA, England.

Personal plates

Got something you want to tell the world? Stick it on your license-plate frame with the Custom Frame kit. It comes with a set of self-stick vinyl letters. White ABS plastic frame: $3.95. Chrome frame: $5.95. Royalmark, 11782-18 Western Ave., Stanton, Calif. 90680.

Extension hose

No need to remove the luggage or tire cover to inflate or check the pressure of a hard-to-reach spare—use an extension hose. The four-foot hose is secured by a spring clip to the trunk floor. It's $5 ppd. from Varsity Accessories Ltd., 2a South Parade, Oxford OX2 7YB, England.

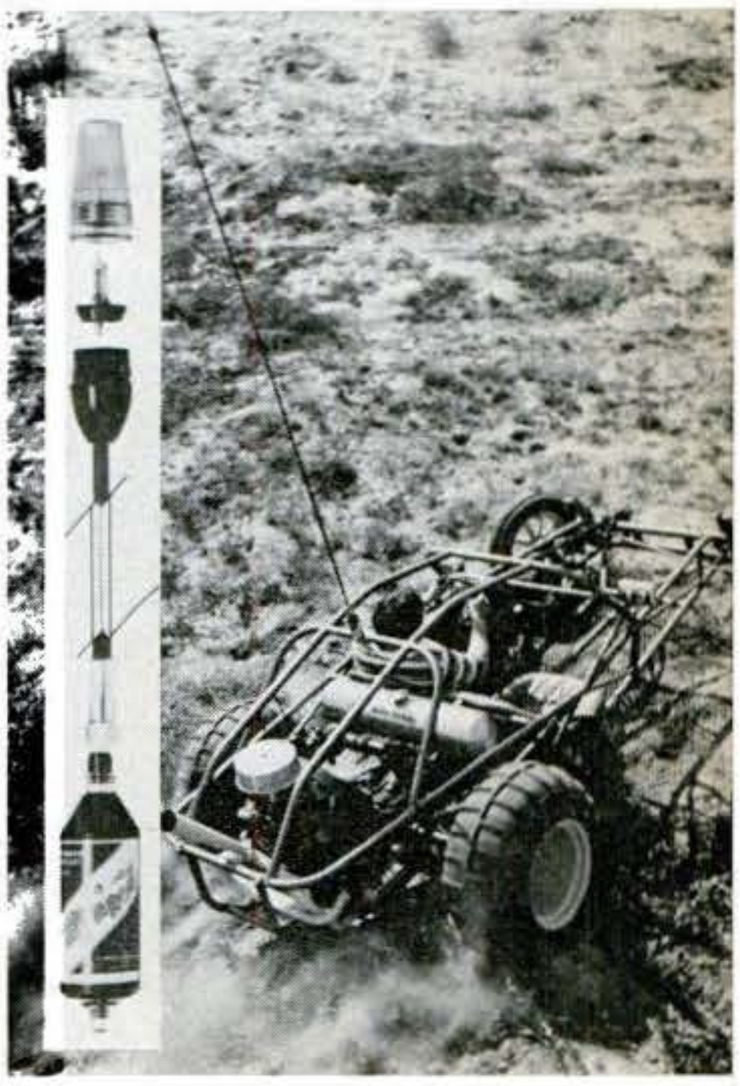


RV rack

Going camping? Take your motorcycle, gas cans, and extra cargo along with the Hall-Rack. It bolts to your RV's frame so neither drilling nor welding is required, says Hall-Rack Corp., 304 N. Water St., Kent, Ohio 44240. Price: $150 for standard model, $250 for deluxe unit.

Off-road beacon

Lost in the wilds in your off-road vehicle? You'll be found more easily if you've installed a Lite n' Rod strobe. Mounted on an eight-foot rod, it emits a 750,000-candlepower flash 80 times a minute. $59.95. Illuminated Products, Box 11930, Santa Ana, Calif. 92711.



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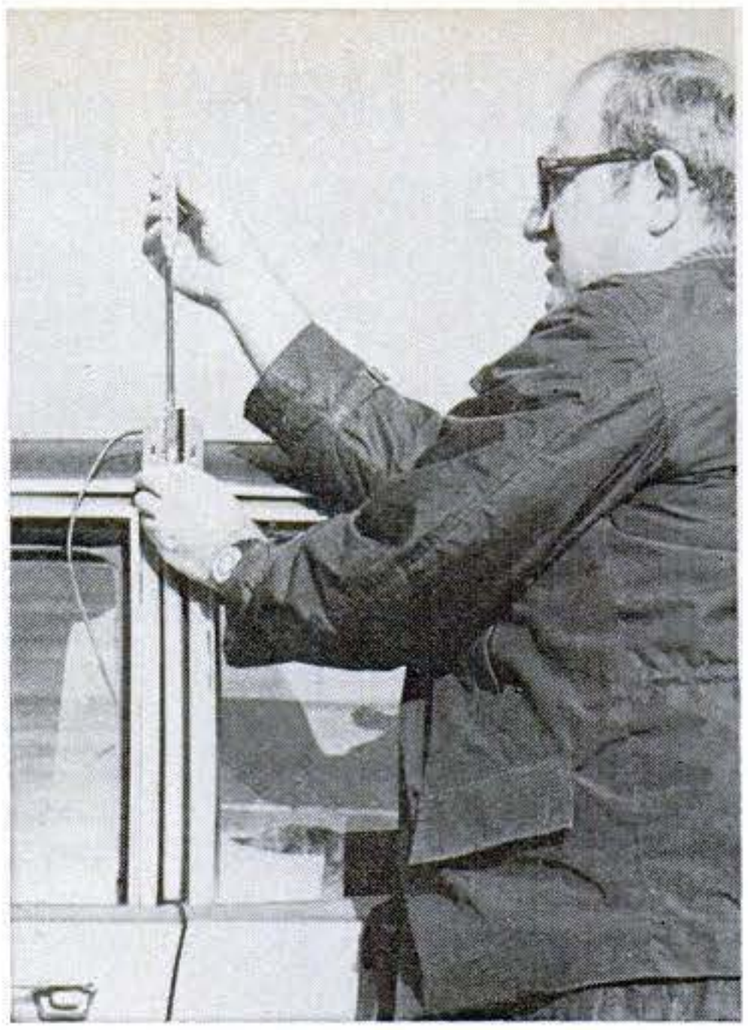
Field tests reveal strange facts about locating your car's

CB antenna



Use these patterns to help you buy and install the right CB antenna system

By HERB FRIEDMAN

Is there a best place to mount a CB antenna on your car? In theory, all mobile antennas are omnidirectional—they transmit equally well in all directions. But what happens when they are placed on or near a metallic surface such as your bumper, roof, cowl, or trunk lid?

To find out, we did extensive field tests, carefully measuring signal strength in all directions from many different antennas mounted at various places on a car. The results—the transmission patterns you see—vary enormously, and can help you choose the right location for your CB antenna and the right type of antenna as well.

Our mobile lab was located at least 200 feet from any obstruction that could possibly alter the results. Before each test, power levels and SWR (standing wave ratio) checks were made to assure equal levels of signal to each antenna.

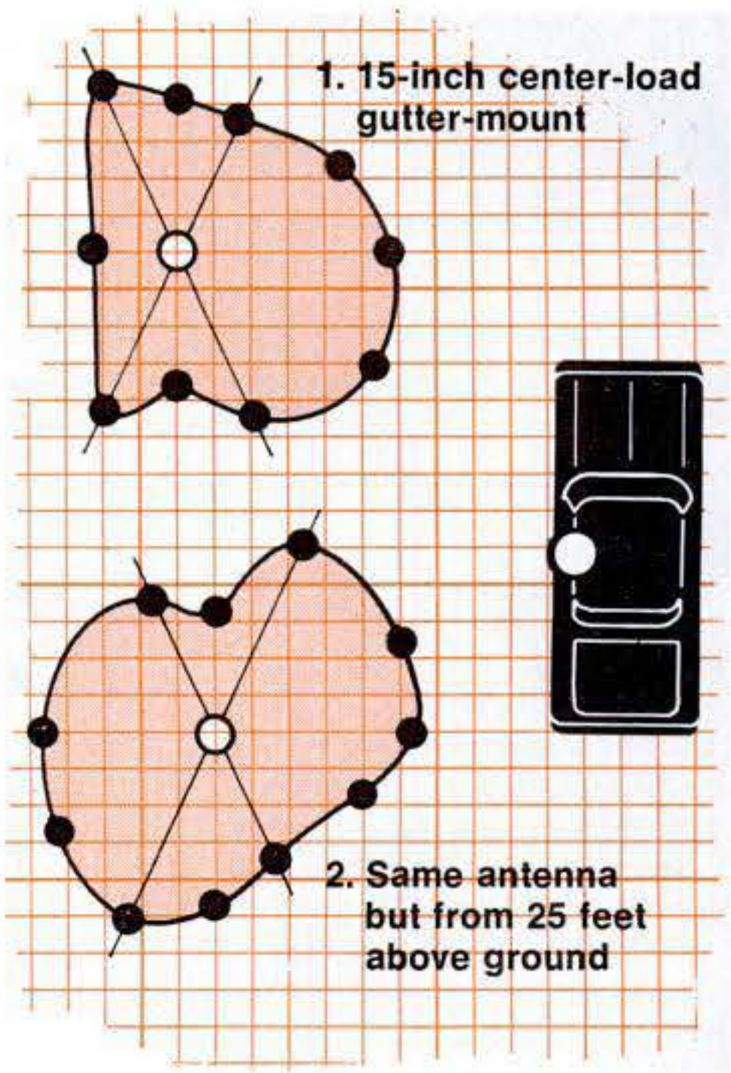
The resulting patterns represent what you would "see" if you were looking straight down on the antenna. The car drawings show where the antenna was mounted for each test, and all patterns are drawn to scale for easy comparison.

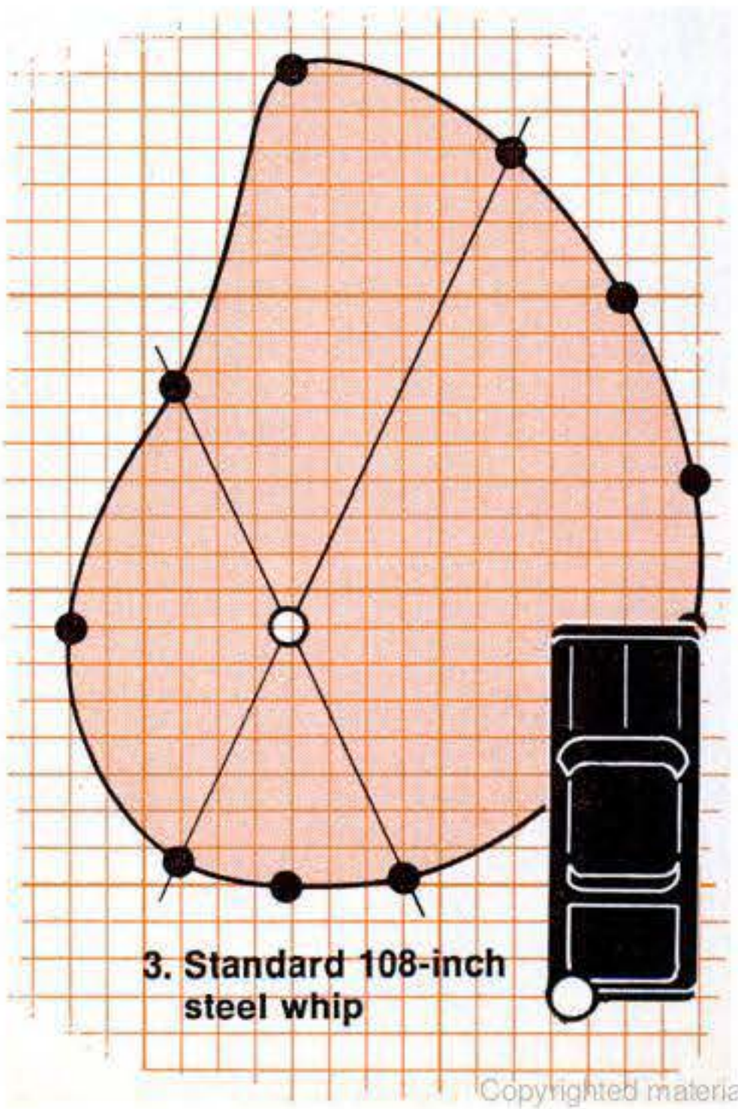
In general, the radiation patterns conformed to basic rules: The higher the loading coil (antennas come with base, center, or top loading coil built in) and the greater the antenna height, the better the signal. And the direction of the signal followed across the path of the most metal in the vehicle.

Choosing the right location and the right antenna, however, depends on the type of communicating you do. If most of your CB communications occur on the highway, look for patterns that beam the signal to the front and rear of the vehicle. For around town, however, a pattern with relatively equal strength in all directions is preferable.

For maximum distance, look to the larger patterns, but be prepared to swap signal strength for an antenna of practical size. And for short communications, a relatively small antenna can be used—but pick a mounting location that produces the type of signal you can best use.

Keep in mind that antenna quality is not purely in its transmitted signal—also check how well it's constructed before you buy. PS





Pattern results: All patterns are drawn to scale for ready comparison. Inside circle indicates antenna. Patterns 1 and 2 are for a clip-on gutter-mount antenna when the signal is checked at ground level (1) as opposed to a signal received 25 feet in the air (2) to simulate a base-station reception. Antenna 3 is generally used as a reference antenna; it's a 108-inch steel whip mounted on the bumper. Patterns 4, 5, and 6 show the differences between loads and antenna lengths; all are mounted at the rear of the trunk lip, near the bumper. Patterns 7 through 11 are more omnidirectional because of the centering of the antennas on the car. A magnetic-mount antenna is used for patterns 12 and 13. Signal strength is considerably lower.

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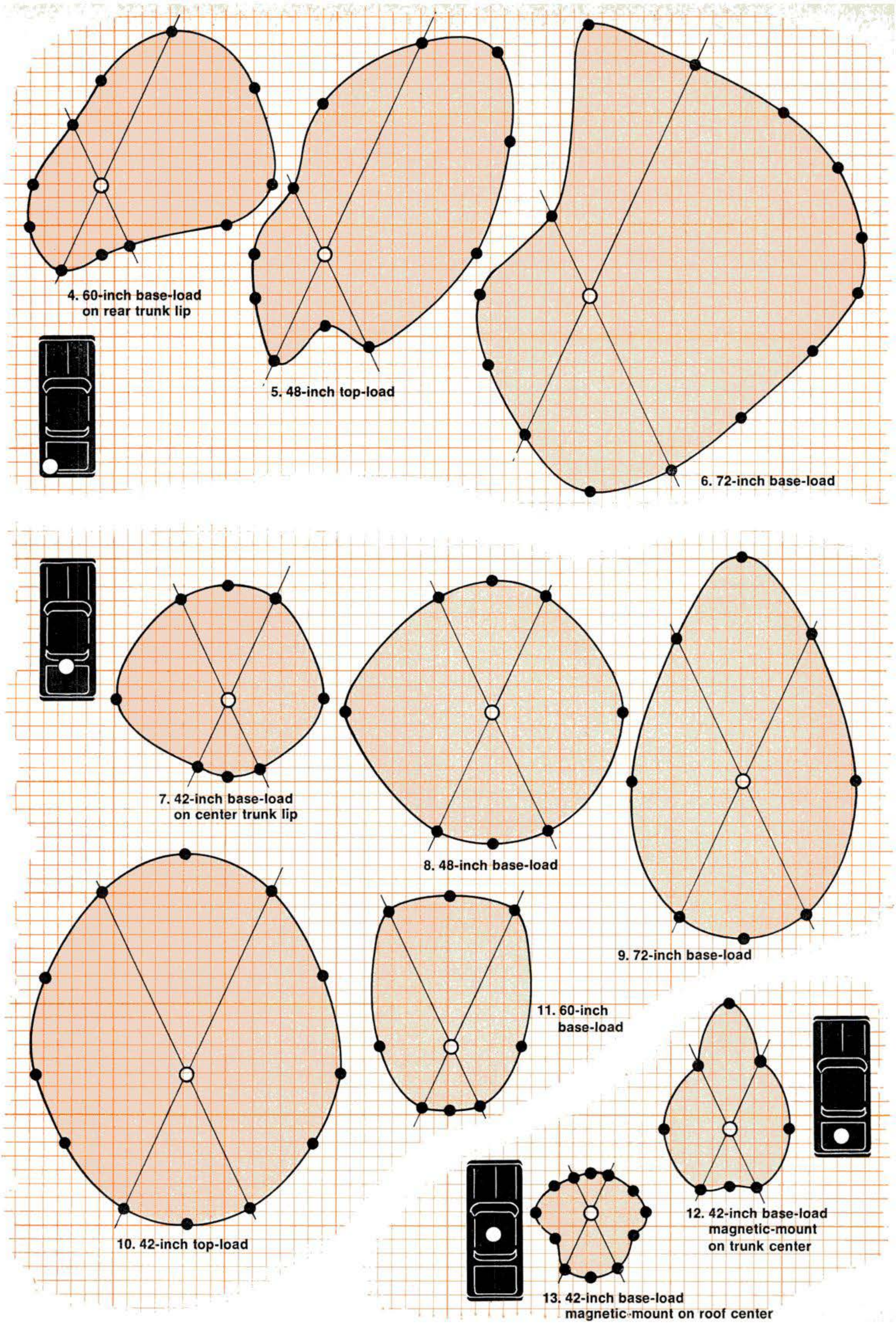
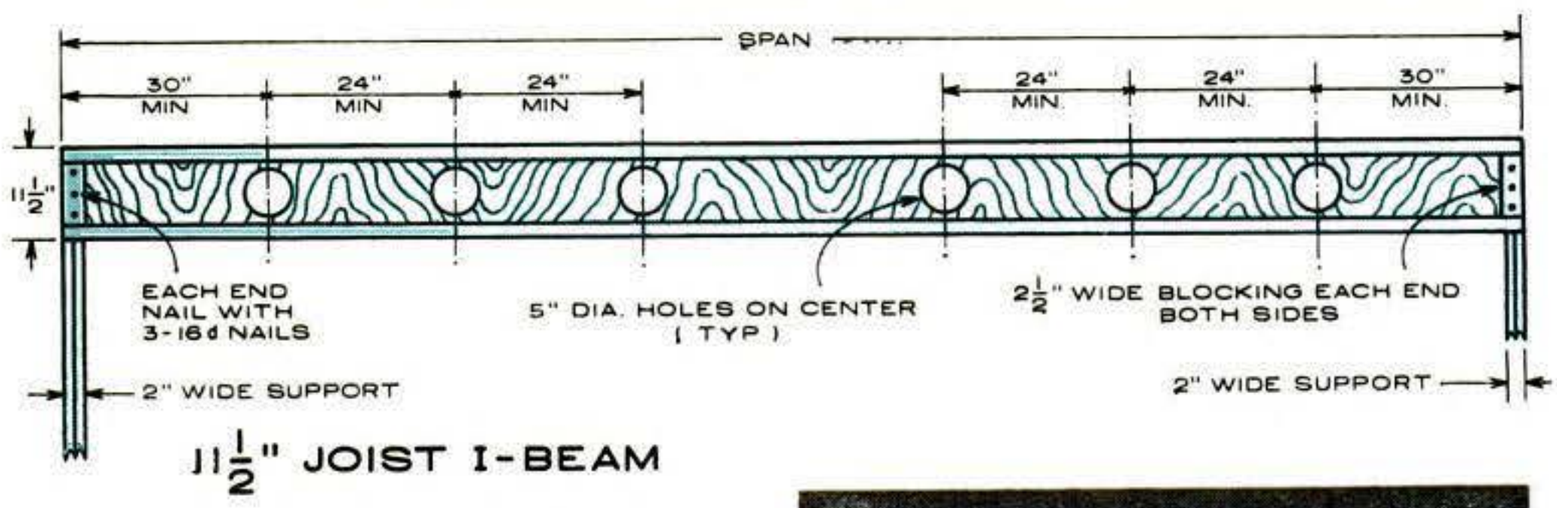
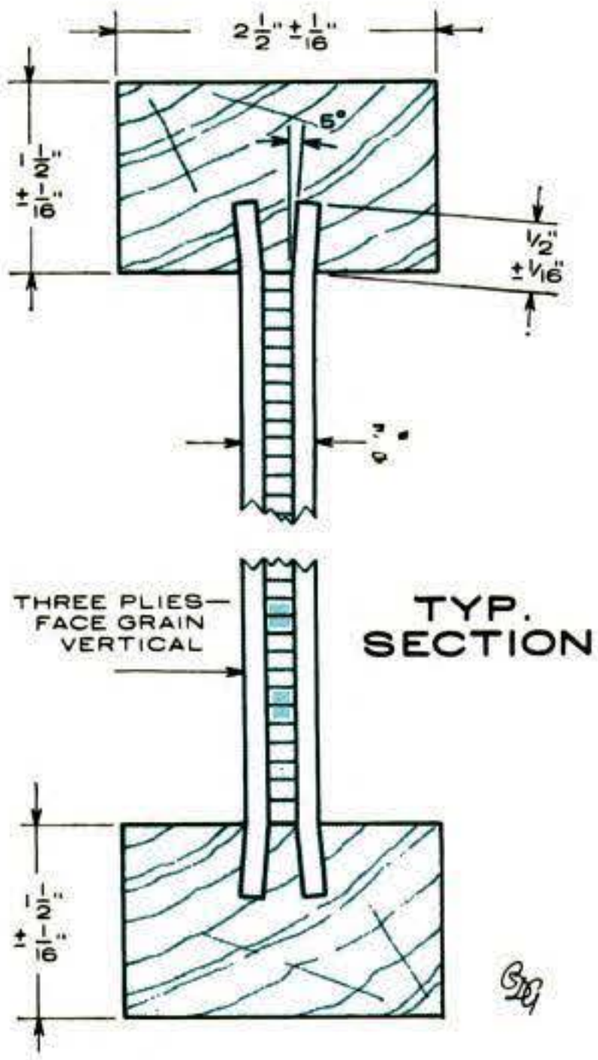

4. 60-inch base-load on rear trunk lip
5. 48-inch top-load
6. 72-inch base-load
7. 42-inch base-load on center trunk lip
8. 48-inch base-load
9. 72-inch base-load
10. 42-inch top-load
11. 60-inch base-load
12. 42-inch base-load magnetic-mount on trunk center
13. 42-inch base-load magnetic-mount on roof center

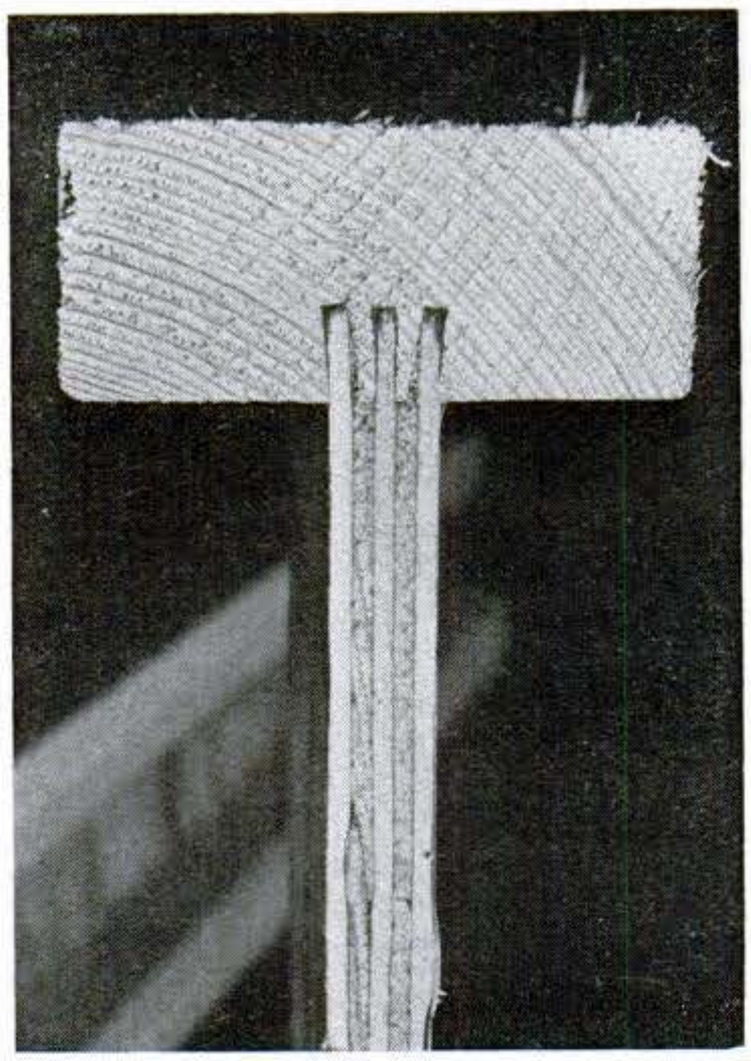
Wood I-beams

save energy, save lumber, save money



11½" JOIST I-BEAM





2x6 wall stud is shown above in preassembled wall section. Stud consists of ripped 2x4 widened to 6" by insertion of noncontinuous web of ⅜" plywood. Gaps can be stuffed with insulation.

Drawings show 11½" joist I-beam. Chords are Douglas fir/larch 2x3's; web is three-ply ⅜" plywood. Closeup photo of 20" I-beam with 2x4 chord and five-ply web shows 5° splay where web joins.

By BARRY LOPEZ

TUALATIN, ORE.

I've just come from a talk with Jim Keller and William Nickerson of Wood I Systems. They've begun production of an advanced wood I-beam that has great potential for reducing both heat loss and the amount of wood used in home construction.

Wood I-beams have been around for a while, but to avoid shearing where the chords met the web, chords formerly had to be of expensive laminate construction. Keller and Nickerson discovered that making longitudinal cuts in the chords at a 5° angle to hold the plies of the plywood webbing (see drawing) would permit the use of standard lumber for the chords. This simple innovation made a just-as-strong wood I-beam that could be priced competitively with standard lumber, and be even cheaper in the larger dimensions.

The I-beam design reduces by about half the amount of wood fiber needed to do the job and—equally important—permits use of small-diameter trees to create large-dimension pieces. Also, says Wood I Systems, using the I-beam in place of conventional framing will cut overall heat loss in a house by 15 percent. Space formerly occupied by wood fiber can be filled with materials that have a higher R-factor.

Other advantages? They're much lighter. I picked up an 18-foot-long 20-inch header—the structural equivalent of an 18-foot 4-by-20—and walked off with it. And, though prices are not yet final, they are expected to be as much as one-third less than for dimension lumber.

The International Conference of Building Officials (ICBO) has certified the Nickerson-Keller I-beam as a replacement for solid 2x12, 4x14, 4x16, 4x18, and 4x20 joists and headers. In the works are large headers and the wall stud above.

Nickerson and Keller hope to have national distribution through franchised dealers in about a year. For further information, send a stamped, self-addressed envelope to Wood I Systems, 21235 S.W. 108th Ave., Tualatin, Ore. 97062. PS

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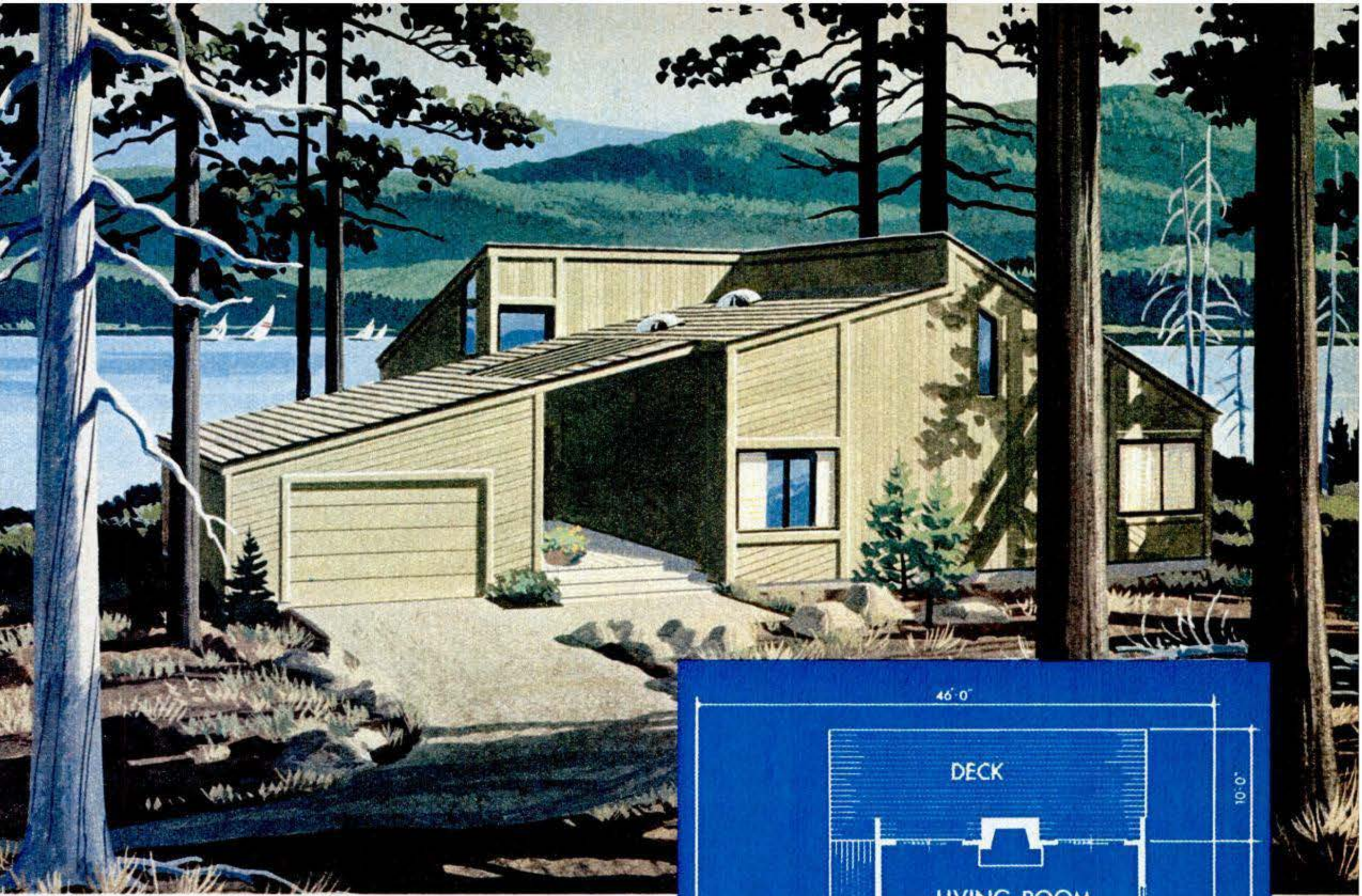

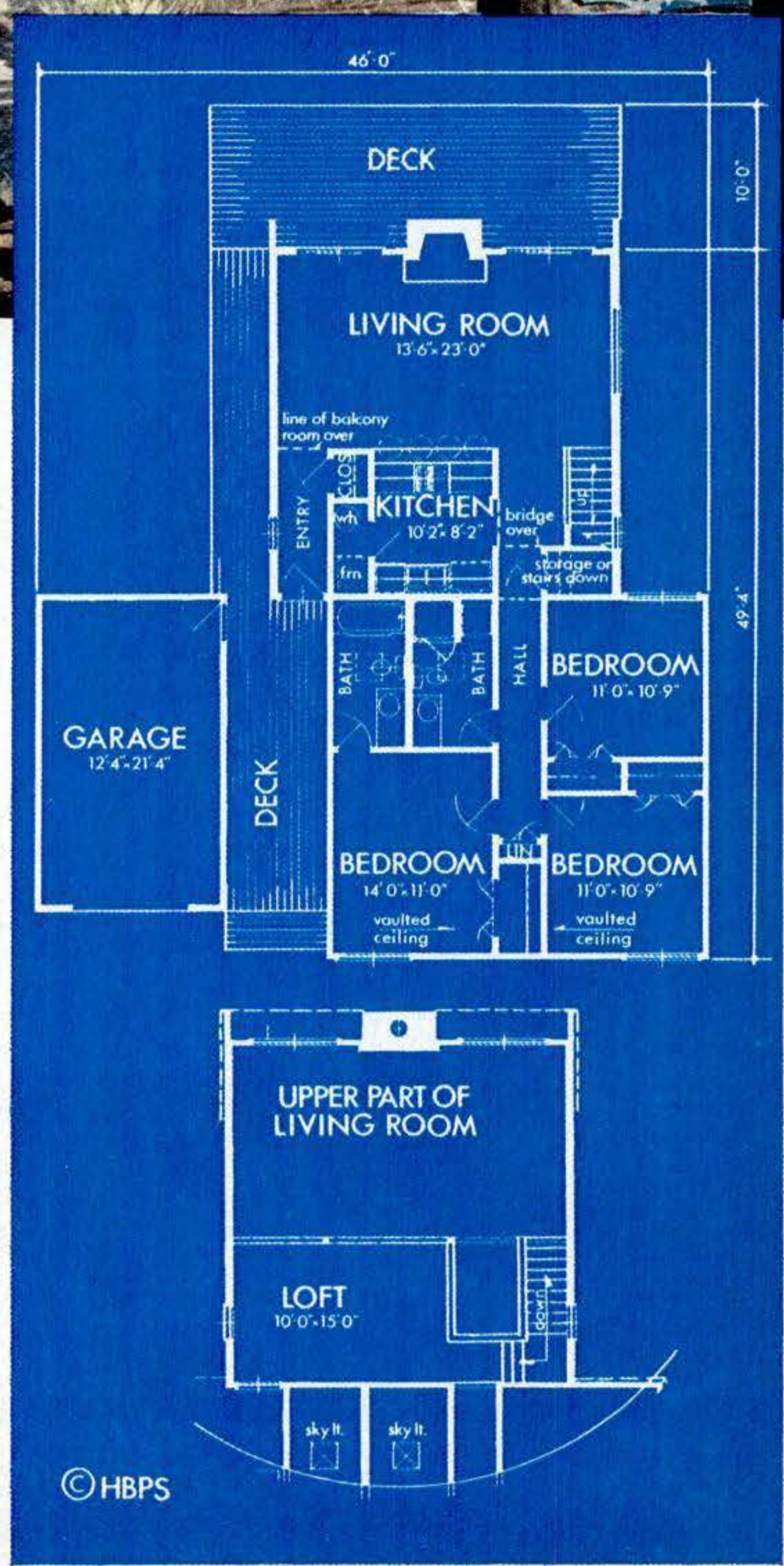

PS LEISURE HOME of the month

Sun cottage
for all seasons

You enter this snug house down a dramatic corridor that starts as a canopied deck between house and garage. The corridor narrows to a low-ceilinged entry hall, then bursts into a sun-filled living room, with the view—whether lakefront or mountain vista—framed across the full width of the opposite wall. Flanking a massive fireplace, sliding glass doors lead onto a deck that runs the width of the house and back around to the entry.

The living room also has a vaulted ceiling and an upper-level bridge that leads to a loft. The kitchen, below the loft, opens across its service counter to the living area. For economy, kitchen plumbing centers on the wall that's common to the bathrooms; the water heater is in an adjacent utility room. The two skylights (shown above) bring sunlight to the bathrooms. The western-wood board siding is applied in a striking combination of vertical and diagonal.—*Al Lees*

How to order your plans

One set of detailed, professionally drawn plans for the Sun Cottage is $60; four sets (for building, financing, and obtaining permits) are $75. Plans will be reversed, side for side, for $12; building-materials list is $10; plumbing and wiring diagrams are $5 each. Specify plan 916-1 for house with excavated basement, 916-1A without. Orders or inquiries to: Home Building Plan Service, 2235 N.E. Sandy Blvd., Portland, Ore. 97232.

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Offbeat new planes

from the Paris Air Show

POLISH AGRICULTURAL BIPLANE, PZL-MIELEC M-15

ISRAELI ARAVA 202 TURBOPROP STOL

By BEN KOCIVAR

LE BOURGET AIRPORT, PARIS

Walk around the world's newest and strangest agricultural aircraft and you face an incongruity. It's a biplane and it's powered by a jet engine. It comes from Poland.

I got a good look at this strange craft and other intriguing designs at this year's Paris Air Show. They are, to put it mildly, unusual.

Don't make jokes about Polish aircraft. Poland is now the main producer of agricultural planes and helicopters for the Soviet-bloc nations. The giant jet-powered biplane is the PZL-Mielec M-15 (facing page), with a wingspan of more than 73 feet. It can carry almost 2½ tons of spray and lay a swath 200 feet wide behind it as it flies, very low, at about 100 mph.

Low-altitude flying, the pilot told me, is the reason for the biplane design. It allows the big plane to bank and turn more safely at the end of each run. A single-wing design of the same wing area and lift would need a much greater span. A low-altitude turn could trip a wingtip.

But why a jet engine for such a slow plane? "Don't jet engines use more fuel?" I asked.

"Yes," was the reply. "But in Eastern European countries, kerosene is cheaper and more available than aviation gas. So the result is less cost."

The turbofan engine requires less maintenance than a big piston engine. It also causes less of the vibration that might fatigue airplane parts. The same engine is used in several other designs. That simplifies parts supply and maintenance. While the plane has a single pilot, a mechanic goes along on farm missions, which are often far from airport maintenance facilities.

Chemicals, either liquid or dry, are carried in the two fat struts that connect the upper and lower wings. They are forced out of nozzles on the lower wings by compressed air from the jet engine's first compressor stage.

In most ag planes, the pilot sits back of the engine and wing. But the pilot of this biplane is well forward, where visibility is excellent—and he is ahead of the chemicals.

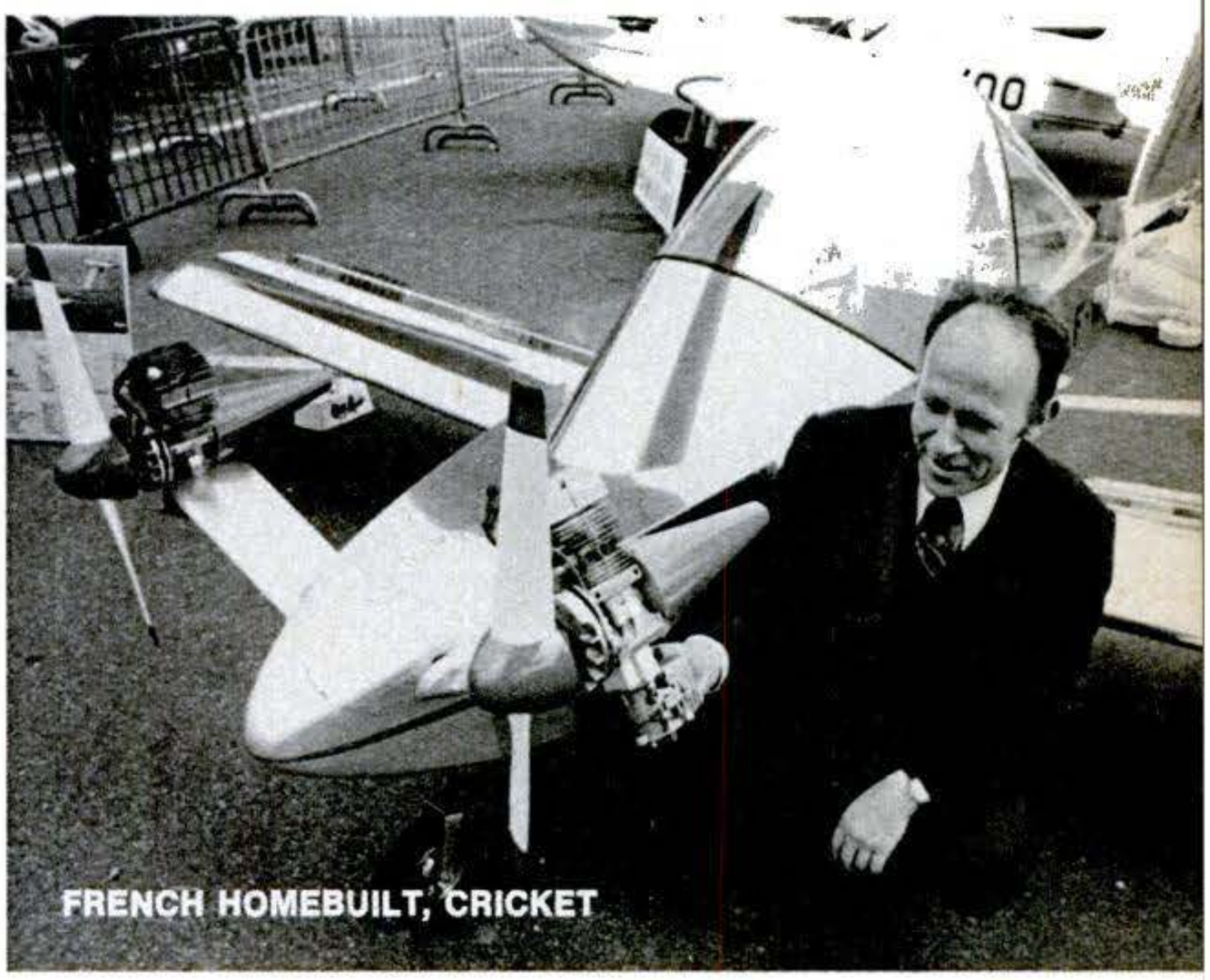
Another interesting Polish design, the M-18 Dromader (below), combines parts of American and Russian ag planes. It's a 58-foot-wingspan monoplane that uses the wing and cockpit of the Rockwell Thrush Commander and the 1000-hp engine and landing gear of the old Russian An-2 multipurpose biplane. This big monoplane has the pilot protectively sealed inside its rear cockpit. Wire cutters in front of the landing gear protect the plane from low power lines. A steel cable runs from the cockpit to the top of the tail fin so that, if the plane flies under any wires, they won't strip off the rudder.

The improbable-looking Polish PZL jet-powered helicopter, the Kamov Mi-2 (bottom left), is also used for agricultural spraying. Hung on

Continued

POLISH M-18 DROMADER

POLISH KAMOV MI-2
JET-POWERED HELICOPTER



FRENCH HOMEBUILT, CRICKET

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each side of the stubby fuselage, like wicker baskets on a burro, are two giant fiberglass hoppers that can carry 600 liters each and blow either liquid or powdered chemicals over a wide area, using the downwash of the rotor. The basic helicopter is also used for passenger transport and by the Soviet navy for antisubmarine work.

From Israel

The Israelis have added small winglets to the wingtips of their Arava 202 STOL (short takeoff and landing) turboprop (shown on the first page). One of their young engineers told me that the winglets increase payload and/or range of this plane by about 12 to 15 percent. The idea of using such winglets is also being explored by the U.S. Air Force and NASA to extend the range of military and civilian planes [see "Fuel-Saving Aircraft," PS, Sept. '76]. But it looks as though the Israelis will be the first to put them on production planes.

The smallest plane I saw at the show is an ingenious 14-foot-wingspan French home-built design powered by two McCulloch 125-cc Go-Kart motors. These develop all of 11 hp at 7000 rpm. The craft was the second of its kind built. The first one lost a prop blade during flight. The resulting vibration shook the engine off, but the pilot landed unharmed.

The plane's designer, Mich Colombian, an aeronautical engineer with Aerospatiale, calls it "Cricri," French for "cricket." He told me that he intends to market plans and possibly kits after he completes his research. The plane flies well, he says, cruising at about 100 mph.

A French manufacturer, Avions Robins, has built an unusual U.S.-designed home built, the Dyke Delta (below). This triangular-wing four-seater has the pilot sitting center in front and three passengers on a bench behind. With its 180-hp reciprocating engine it should be a cheap plane to make. Its wings are designed to come off easily so it can be towed or trailered home from the airfield.

But flying a delta-wing plane is different from piloting conventional types, and Robins wonders whether pilots with limited flying time, who are typically the ones to buy inexpensive planes, will have enough experience to handle this unusual design.

Test pilots tell me that delta designs fly very nose-high in takeoffs and landings and have a high sink rate at low speed, but they also do not stall or "drop out" abruptly at low speeds—which is what happens to most conventional-wing planes. The Concorde SST, for example, is reputedly easier to land than a 707.

Aerobatic planes

Czech aerobatic-competition planes are traditional world leaders, and the Czechs have a new, trimmer single-seat version of the Zlin, the Z-50 (top of facing page). This plane has a streamlined nonretractable spring-steel landing gear, like that used on Cessna planes. The canopy is a one-piece bubble. The Z-50 should be a tough competitor.

The Russians also have a new aerobatic plane, the Yak 50 (bottom of facing page). Its design, with a radial engine, makes it look like a slightly updated World War II fighter. Nonetheless, the plane won this year's international aerobatic competition.

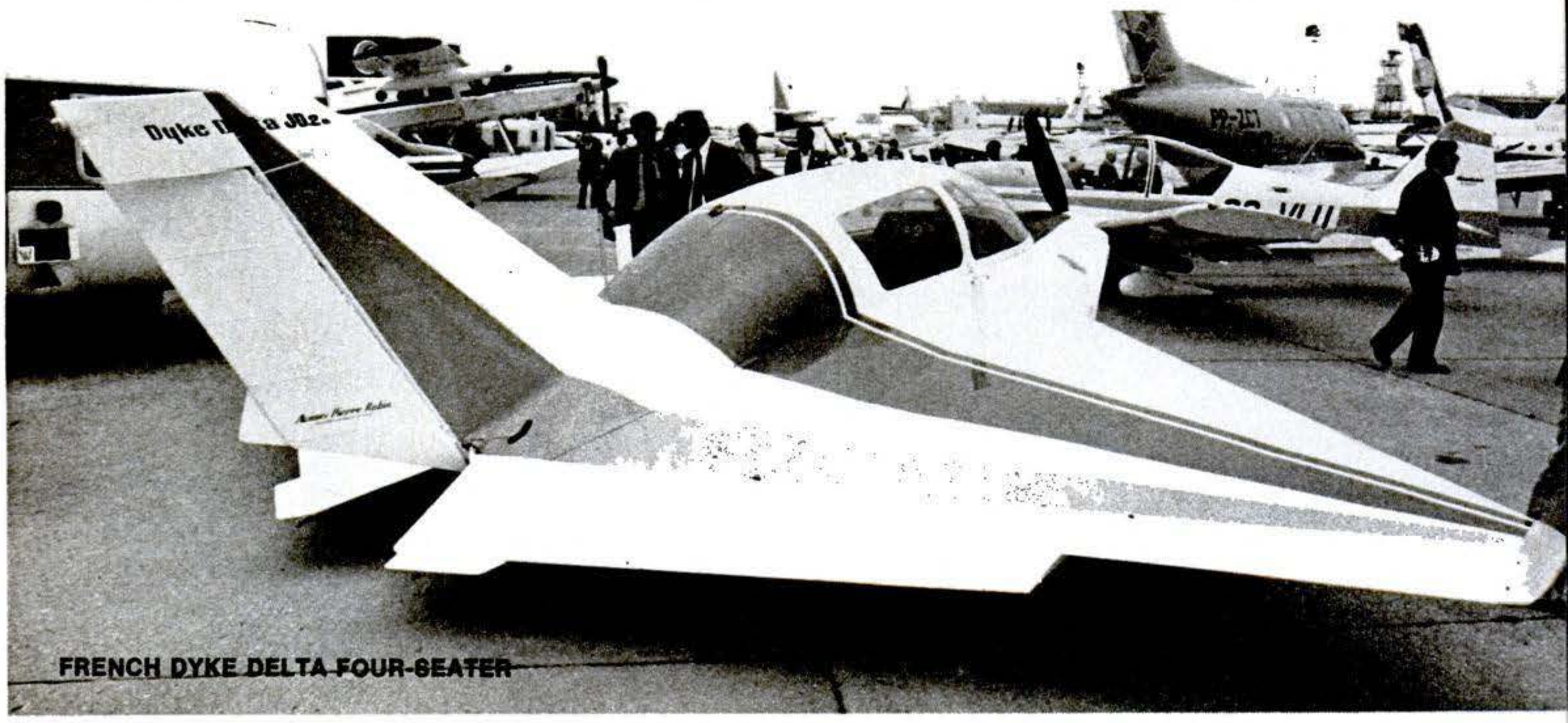
A new English idea in two-seat aerobatic trainers was shown to me by the designer, Desmond Norman. He was one of the founders of the company that makes the famed Britton-Norman STOL Islander and Trislander. Norman's new design is the Firecracker (center of facing page), a tandem-seat prop-driven craft with a stubby 26-hp Lycoming engine.

Norman calls his concept a "technology-transfer program" and does not plan to manufacture the plane himself. The plane is intended for small countries that depend on foreign aircraft industries for supplies. Norman offers a 5½-year program for training in manufacturing and marketing within each country. In batches of 100, planes would cost an estimated $125,000 each.

Whether or not this program will succeed, time will tell. It is, in a way, a small version of what has been going on in most European countries since World War II, where many military and civilian planes have been manufactured and sold at a loss in order to help set up a basic aircraft-production industry and keep up local employment. The hope is that eventually a profitable industry will develop.

The plane is designed to be made without sophisticated manufacturing facilities. No costly presses or heat-treatment ovens are needed. About 85 percent of the equipment that must be bought from outside sources, such as engine, tires, landing gear, brakes, and aluminum, is made in the U.S. Sounds like a nice concept for home-builts, too.

I was particularly interested in Norman's use of Hoerner wingtip design, the same basic wingtip design that is used on the Islander, which has no built-in wing dihedral. It has three effects: It provides the dihedral for natural stability; it has "washout"



FRENCH DYKE DELTA FOUR-SEATER

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CZECH ZLIN Z-50, AEROBATIC PLANE

or twist downward, allowing the outer tip of the wing to stall after the center area. Result: The plane simply sinks straight down in a stall instead of falling off to one side or the other. Finally, the wingtip shape pushes the tip vortex out, in effect increasing the aspect ratio (wingspan to chord) of the wing, making for less drag in the stubby-winged plane and resulting in better low-speed performance. It does this by reducing the vortex caused by the mix of high pressure on the bottom side of the wing and low pressure on the top. The wingtips can also be designed as optional fuel tanks holding about 30 gallons each.

All told, the Paris Air Show revealed exciting new developments on the European airplane scene. Europe doesn't crank out the total numbers of planes that we do in the U.S., but it certainly doesn't lack novel ideas either. PS

ENGLISH FIRECRACKER, AEROBATIC TRAINER

RUSSIAN YAK-50, AEROBATIC PLANE

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Big sound from those new **mini-speakers**

Wallet and wall space can both be accommodated. From top to bottom, left to right are: Cusom Craft Mark I, $82 ea.; Braun L200, $260 a pair; Visonik 80, $219 ea.; Visonik 50, $109.50 ea.; Lafayette Pip Speak, $49.95 ea.; Visonik 60, $149 ea.; Braun Output C, $225 a pair; Radio Shack Mini Mus, $49.95 ea.; Advent 400, $35 ea.

PHOTO BY ORLANDO GUERRA

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Don't let their small size fool you—new designs make them a new breed

By WILLIAM J. HAWKINS

Sure, I've heard little speakers before—10-buck "extension" types that sound as if I should get a nine-dollar refund. But now there's a new breed of mini-speakers. They're no longer cheap, but they're not of poor quality, either. You get good, pleasant sound with low distortion—and from a box that's as little as six inches high. These new speakers can solve the space problem when you're setting up a two- or four-channel system. And there's a wide variety of price tags to choose from.

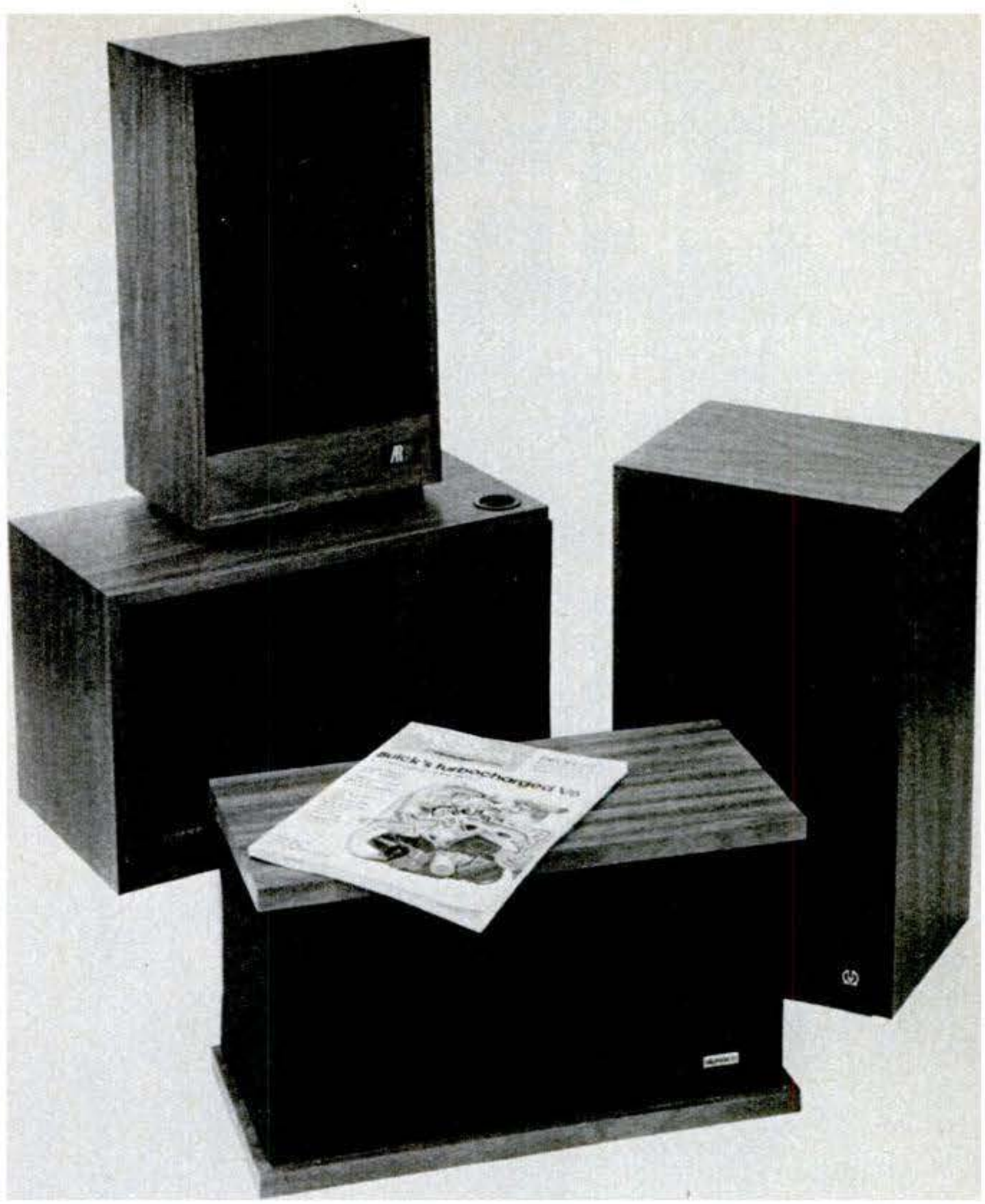
The new speakers represent years of work by the manufacturers to redo basic speaker concepts. In the past, little speakers were plagued with distortion, low volume, and a poor frequency response that resulted in no bass reproduction and a "honky" midrange. While nobody has changed the laws of physics to design the new minis, each maker has tackled the problems by using different hardware.

Two separate methods, for example, are used to correct poor frequency response. Normally, any single speaker will reproduce one set of frequencies louder than another. To level off these ranges and produce a flat, non-honky sound, Advent uses a built-in electrical circuit. Called an RLC (resistor, inductor, capacitor) filter, it electrically boosts the volume of some frequencies while retarding others. The result is balanced volume across its audio range.

Other makers have followed the idea introduced by Braun: separate speakers to reproduce each frequency range. While the Visonik 80 and a future Braun L 400 have a three-way system (woofer, midrange, and tweeter), most makers use an air-suspension midrange speaker for low-to-medium frequencies and a tweeter for high ones. And, as in larger speaker designs, a crossover network (an electronic circuit) sends the right range of frequencies to each speaker for equal, flat reproduction.

To get good audible bass response, large amounts of air must be moved. This presents little problem for large woofers since relatively small cone movements are amplified by their large surface area.

To compensate for a small surface area, however, the minis use a heavy cone supported by a special suspension to allow greater in-and-out movement. This movement, called excursion, allows the speaker to move much larger volumes of air for its size. Because of the enclosure and other design trade-offs, however, the resulting bass response from the minis won't knock the nails out of the walls—but it sure beats anything ever coaxed out of a small box before.



Not all small speakers are "minis." These, for example, are smaller than a bookshelf speaker, but you won't be able to hold one in your hand. In rear is AR 18; below it, the Bose 301. At right is a Pioneer 60A; in front is Dynaco's D20XL.

Distortion was another early problem of little speakers. It can come directly from the speaker itself or from the enclosure that surrounds it. Better-quality speakers removed much of the unwanted noise, but the box required a face-lift.

The thin, poorly designed walls of earlier speaker systems resonated—vibrated—when certain frequencies were produced by the speaker. To eliminate this, manufacturers used stronger materials and additional supports within the enclosure. Advent, for instance, uses extremely dense polystyrene plastic for the box walls and glued masonite supports to stiffen them further. Custom Craft uses hard walnut wood, and Visonik builds its larger speakers out of thick pressboard with a special outside coating for appearance; its smaller model 50 uses a plastic surface. Braun, Radio Shack, and Lafayette use heavy-gauge aluminum.

We listened

So, what does all this get you? As a new class, these shoebox-size speakers produce remarkably pleasant, undistorted, balanced sound. They cannot, of course, handle as much volume or bass as more massive full-size speakers, but their clean, comfortable reproduction would certainly satisfy most people.

As with big speakers, each mini has its own unique color or tonal quality. You may like some better than others, so listen to each before you buy. Prices vary enormously; some are under $50, others well over $100 each. So be prepared for a long shopping day—you'll have many models to choose from. PS

MANUFACTURERS AND DISTRIBUTORS

Acoustic Research, 10 American Dr., Norwood MA 02062; **Advent Corp.,** 195 Albany St., Cambridge MA 02139; **Braun/Adcom,** 114 E. 42nd St., N.Y. NY 10016; **Bose Corp.,** 100 The Mountain Rd., Framingham MA 01701; **Custom Craft,** 819 S. Kraemer Blvd., Placentia CA 92670; **Dynaco Inc.,** Box 88, Blackwood NJ 08012; **Lafayette,** 111 Jericho Tpke., Syosset NY 11791; **Radio Shack (Realistic),** 2617 W. 7th St., Fort Worth TX 76107; **US Pioneer,** 75 Oxford Dr., Moonachie NJ 07074; **Visonik Inc.,** 1177 65th St., Oakland CA 94608.

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914-mpg car

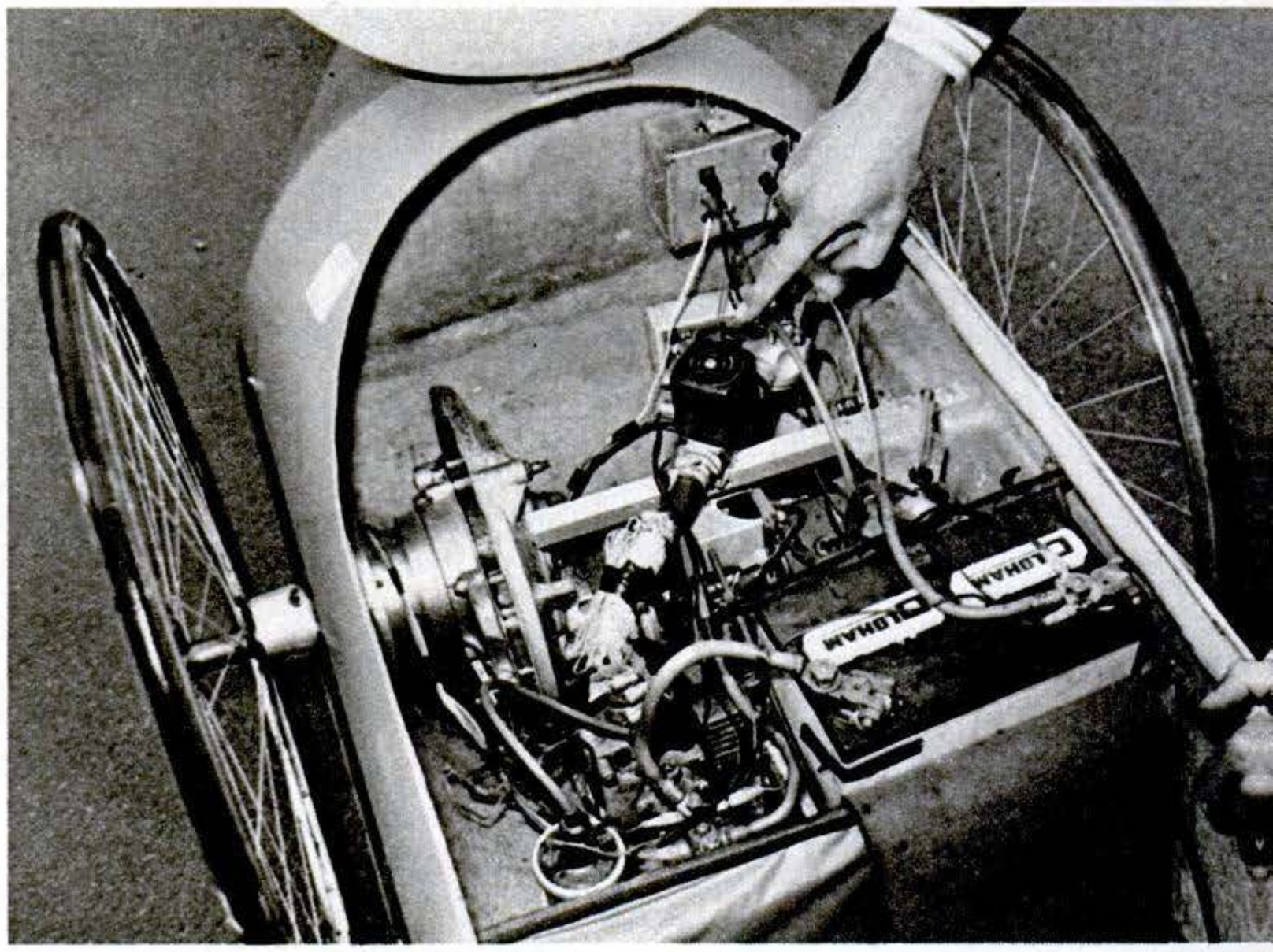
wins super-mileage contest

By DAVID SCOTT

The scene was Mallory Park race track. But there were no screaming race cars circulating around this famous English race course. This was the Shell Super-Mileage Contest—where slow was beautiful, and the target was not a checkered flag but a magical 1000 miles per imperial gallon (833 mpg by U.S. standards, to which all consumption figures given here have been converted).

Built from junk parts by teams of students, the cars all had three unsprung bicycle wheels. Most were powered by Honda 50-cc four-stroke moped engines with electric starters but no gear-shift transmissions. They daintily sipped 100-octane gas from tanks holding little more than an egg cup. Many showed real ingenuity. Some riders had deck-chair comfort; others lay on back or stomach.

Rules were simple. Contestants merely had to lap the track over a 9.5-mile course at a minimum speed of 10 mph. Vehicles had to have at least three wheels, and be driven only by a heat engine. Batteries were allowed only for starting. Fuel tanks were precisely filled, before and after each run. PS



Winning 914-mpg car was built by Cranfield Institute of Technology. Top photo shows car ready to go with driver in place. Cranfield students figured air drag was more critical than weight, so they enveloped machine and driver in a slippery fiberglass body reinforced with carbon fibers for thin-walled strength. The 50-cc engine has a homemade carb with no throttle. It always runs wide open for maximum efficiency during spurts. Fuel is precisely metered according to engine speed by a cunning diaphragm pump (above) operated by pressure pulses of intake manifold. Electric heater in intake manifold helps fuel vaporization.

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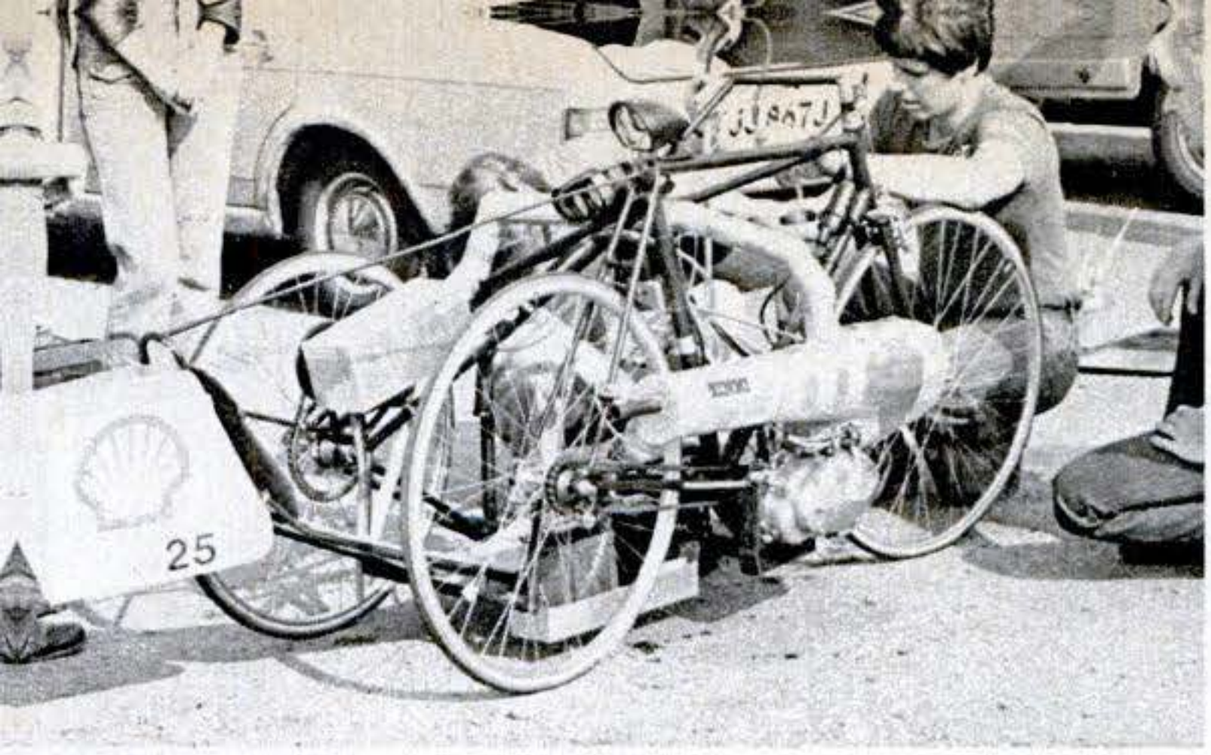
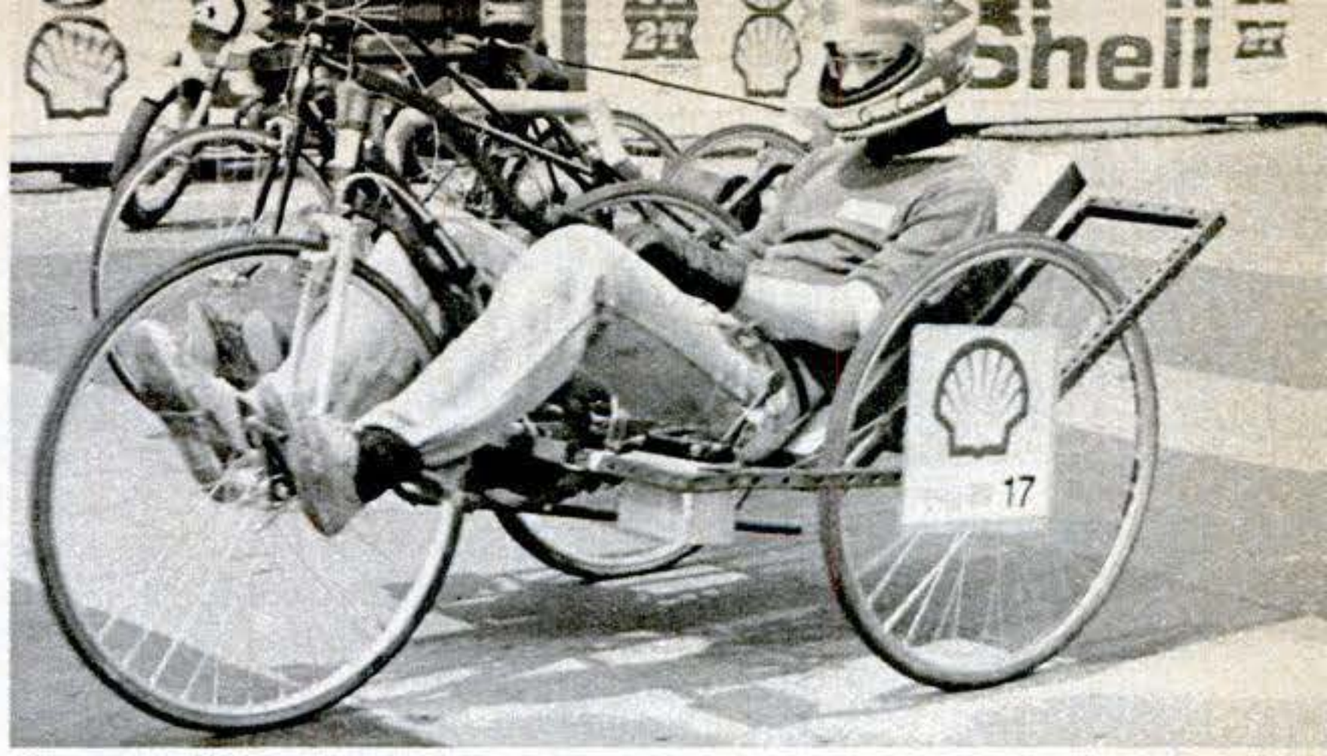


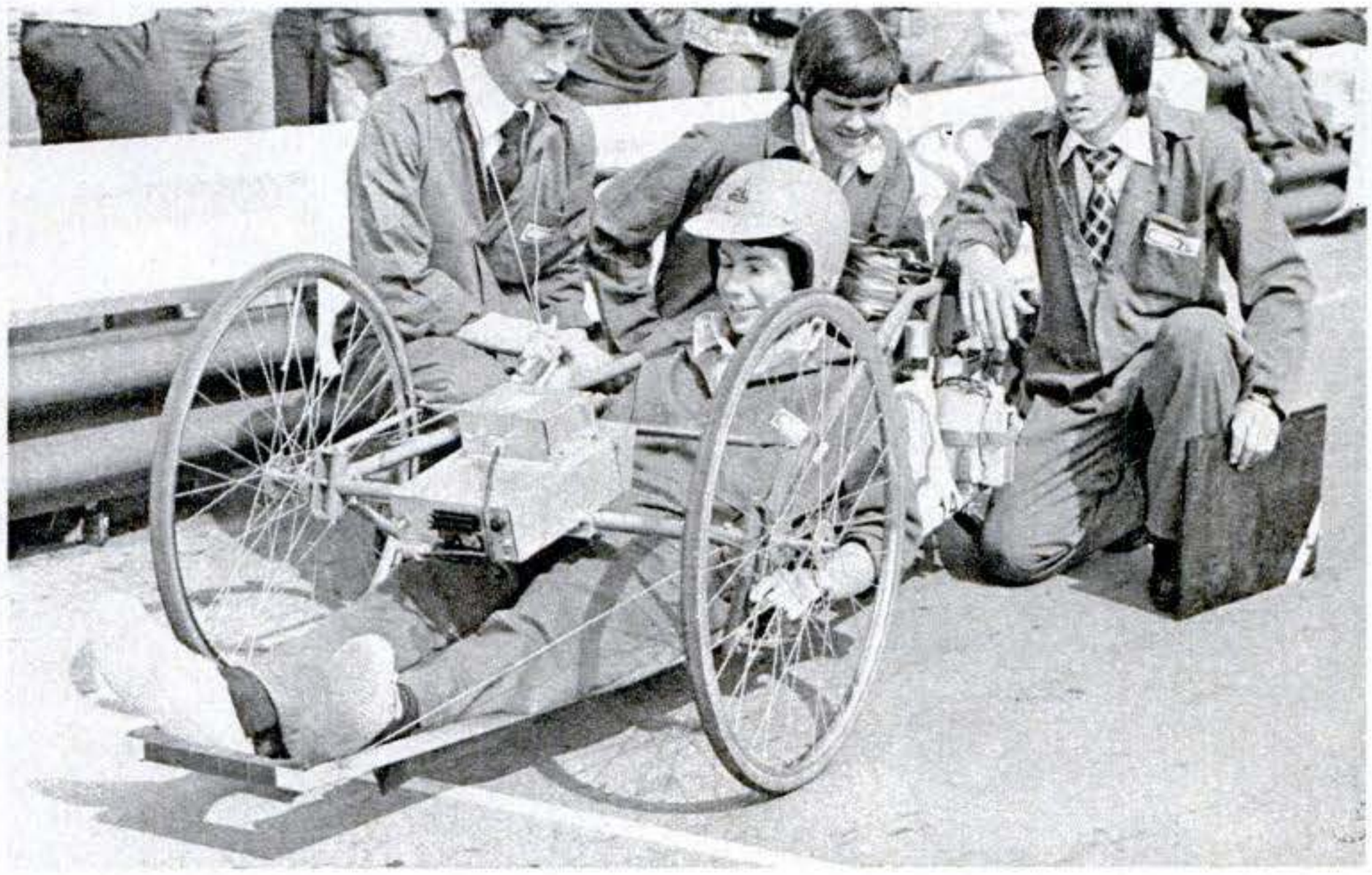
Hybrid machine from Tempere University, Finland, has both gas and steam engines. At 687 mpg it had third best gas mileage, but as a foreign guest it didn't formally compete. The dual-mode system has excelled in past Finnish economy competitions, where the course is longer and hillier than the English one.



Loughborough University of Technology went for rider comfort —and paid the price, with only 403 mpg. Lightened steel frame provides deck-chair seating, with footrests on front-wheel hub. Hand controls are conveniently placed. "Just to have completed the run was an achievement," said its designer.

Ford rig did 635 mpg, for fourth best. Like several others in the contest, it is essentially a bicycle with an outrigged third wheel. Its engine is cocooned to retain heat during shutoff (the course is run with only spurts of power) when electric fuel pump stops flow to the carburetor.

Pirelli did 542 mpg, helped by body envelope made of fabric stretched over a light space frame. Shell's own experience indicates that streamlining can be worth 200 mpg, even at 10 mph. Accepted driving technique was to accelerate to about 20 mph, then coast until more power was needed.



Two-wheel steerer from Lucas Aerospace achieved 620 mpg, boasts sophisticated electronics. Minicomputer lets vehicle accelerate to 17 mph, then shuts down engine and restarts it when the coasting rate drops to a walking pace. Car's average speed was 10.4 mph. Digital speedometer shows average speed during run.

At a mere 400 mpg, Cambridge University scored better in technology than performance. Feather-light chassis is built from honeycomb sandwich material used as flooring in jumbo jets. Racing tires have inner tubes of rubber-coated silk. Engine is really small: a 17-cc unit from a Honda electric generator.

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Today's digitals

–precise timekeeping, and much more

Array of quartz digital watches includes (top group, left to right) Microma's Micro-Glo LCD stopwatch with tritium dial ($100); Hewlett-Packard's HP-01 do-everything calculator/watch ($650); Pulsar's Pulse-Time Computer that monitors your pulse besides giving complete time and date information ($395); green LED from Pulsar ($150); Seiko World Timer, multiple-time-zone watch ($215). Bottom group, left to right: Monte Carlo game watch from Unitrex ($50); programmable LED message watch, Windert ($90); Texas Instruments' new tritium-dial LCD ($38); Mercury Time's LCD Global Executive with complete time and date functions, stopwatch, counter, and multiple time zones ($130); Microma's LCD for women ($50); women's LCD with tritium backlighting from Micro Display Systems ($120); Micro Display Systems' tritium-dial men's LCD with optional 24-hour display ($90—latest model uses lithium battery). Prices may vary locally.

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By V. ELAINE SMAY

This year, add two new words to your watch vocabulary: tritium and lithium. These two substances have led to basic advancements in quartz digital watches, those silent space-age timers that base their precision on the rapid oscillations (32,768 Hz) of a tiny sliver of quartz. Tritium dials make liquid-crystal-display (constant readout) digitals readable in the dark without your pushing a button. Tritium gas, in a phosphor-coated glass ampule, emits radiation that causes the phosphor to glow. That makes the reflective liquid crystals visible without ambient light.

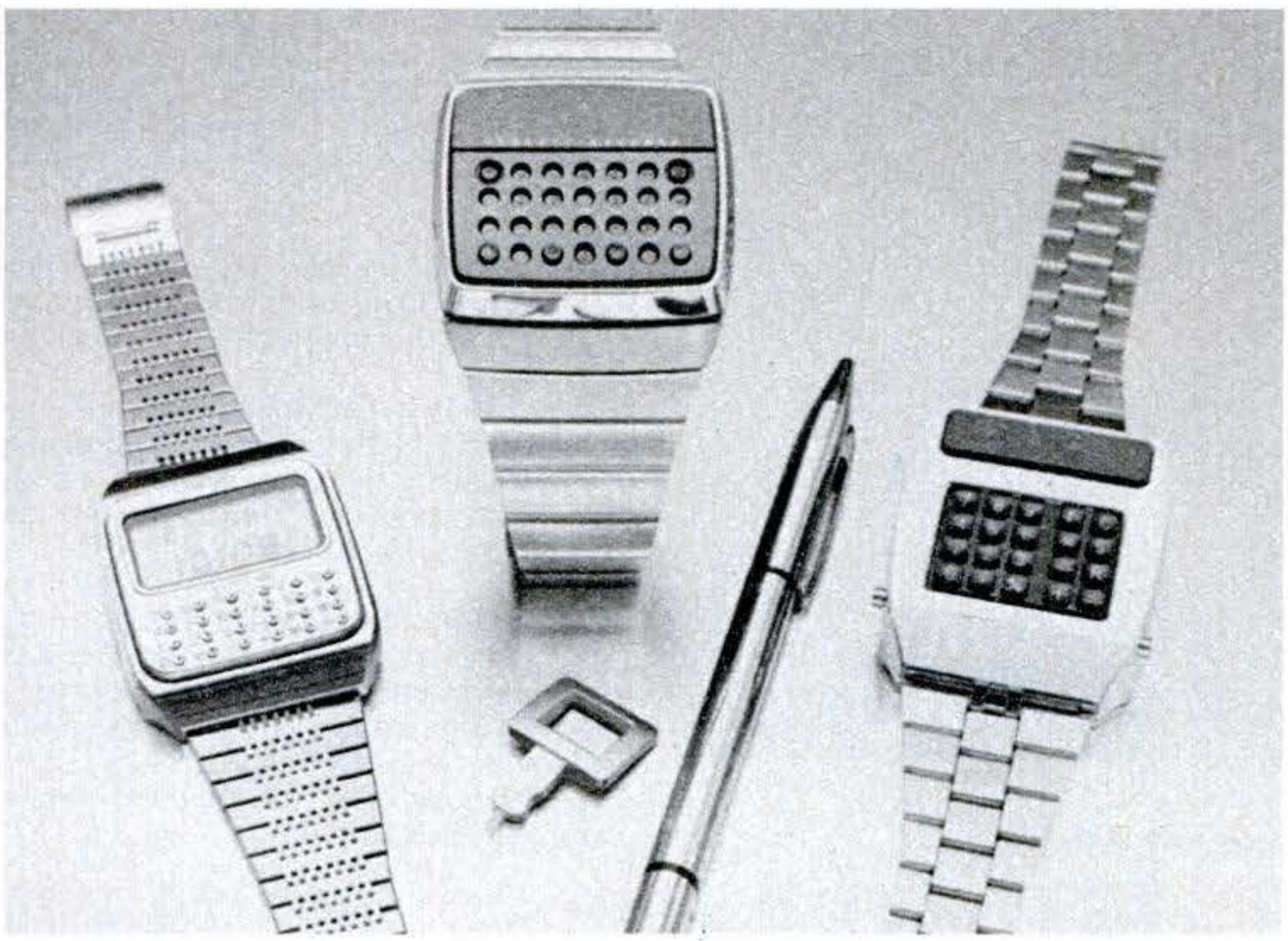
Lithium may solve the problem of short battery life in light-emitting-diode digitals (the ones that light up when you push a button). With a lithium cell, an LED watch should run for a year, an LCD for more than three. And lithium batteries have an astonishing shelf life, delivering 75 percent of their rated potential after 10 years.

New special-purpose digitals, some with surprising functions, are also available. We've collected an intriguing array to show you here. PS

WHO MAKES THEM:

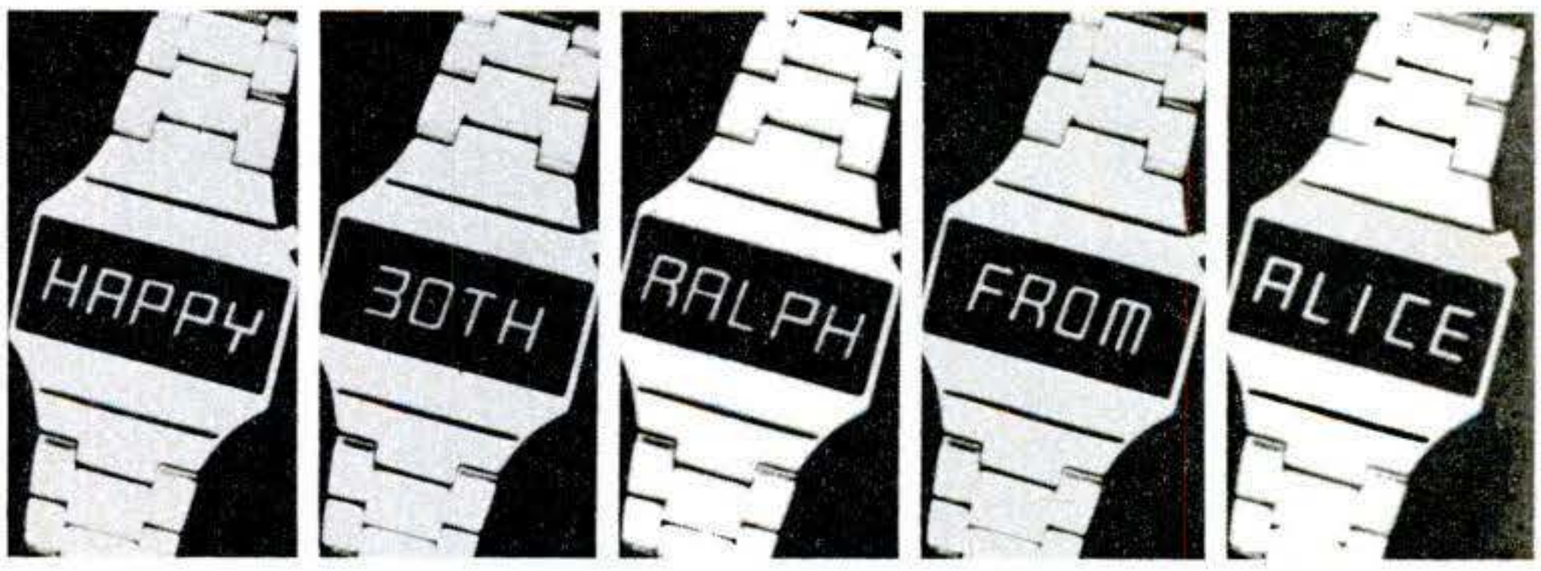
Hewlett-Packard, 1000 N.E. Circle Blvd., Corvallis OR 97330; **Hughes Aircraft Co.,** Box 90515, Los Angeles CA 90009; **Mercury Time,** Leisurecraft Products Ltd., 28 S. Terminal Dr., Plainview NY 11803; **Micro Display Systems, Inc.,** 4350 Beltwood Pkwy. S., Dallas TX 75240; **Microma, Inc.,** 10260 Bubb Rd., Cupertino CA 95014; **Pulsar,** Div. of Jules Jurgensen Corp., 700 Chestnut St., Philadelphia PA 19106; **Seiko Time Corp.,** 640 Fifth Ave., New York NY 10019; **Texas Instruments,** Inquiry Answering Service, Box 5012, M/S 308, Dallas TX 75222; **Unisonic Products Corp.,** 1115 Broadway, New York NY 10010; **Unitrex of America,** 689 Fifth Ave., New York NY 10022; **Windert Watch Co., Inc.,** 448 S. Hill St., Los Angeles CA 90013.

Calling Hong Kong? With a multi-time-zone watch you can find out the time there before you phone. Seiko's World Timer (left) normally displays local time. Push a button and it gives Greenwich Mean Time (hour, minute, day, date). Each successive push changes the displayed time to next time zone. Mercury's Global Executive (right) gives time in six preprogrammed cities around the world, plus one other you choose. It's also a stopwatch, counter, and seven-function watch.



Calculator watches are proliferating. On left is Seiko's new LCD ($350), which displays time while calculator is in use. Hewlett-Packard's HP-01 (center) comes with 100-page instruction book—and you need it. The HP-01 has six interactive functions: time, alarm, timer, stopwatch, date/calendar, calculator with memory. It can do dynamic calculations, such as telling you—second to second—the cost of a long-distance call. Six buttons are elevated; others are recessed. Push them with key-shaped stylus that rides in band, or pen stylus (both come with watch and are shown above), or with other pointed object. Compuchron, on right ($250 from Unisonic), is five-function watch and four-function calculator with memory and percent key. Memory can store three eight-digit numbers, e.g., phone numbers.

Eleven o'clock? No, snake eyes. (But it took 23 tries to do it!) Monte Carlo game watch gives you jackpot, dice, roulette. When three digits stop at same number, J's flash to indicate jackpot. In dice, each push of game button "rolls" two numbers from 1 through 6. Numbers between 1 and 36 rotate for modified roulette. Unitrex watch also gives hours, minutes, date, day, seconds.



Programmable message watch lets you change message yourself (any five words of five or fewer letters), or take it to retailer for reprogramming (with infrared light beam) on machine shown. Just type in message. Module and machine are made by Hughes Aircraft; packaged watch is sold by various companies, including Windert, as shown in color photo.

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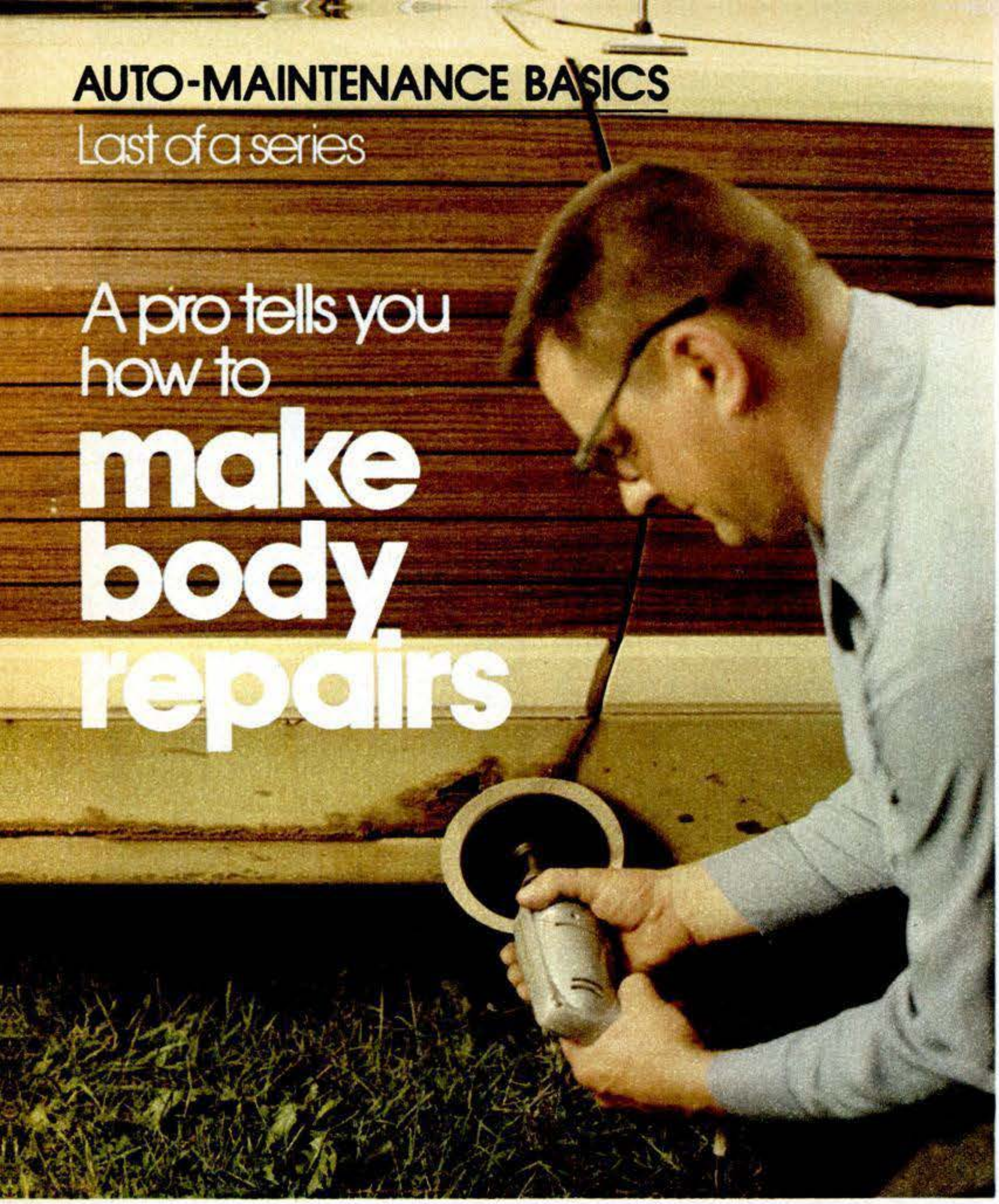
A pro tells you how to make body repairs



By RAY HILL

Scratches, chipped paint, rust, minor dents—sadly, these are part of owning a car. If you've had your present buggy any time at all, chances are it's suffering to some degree from one or more of these unsightly maladies. And one thing is certain: Chips and scratches that expose bare metal will lead to rust if they're not repaired. And rust, if not repaired, is cancerous—it makes a hole that just keeps growing.

1 First step is to judge the size of the rust hole. With holes smaller than a quarter, skip steps 4-6.

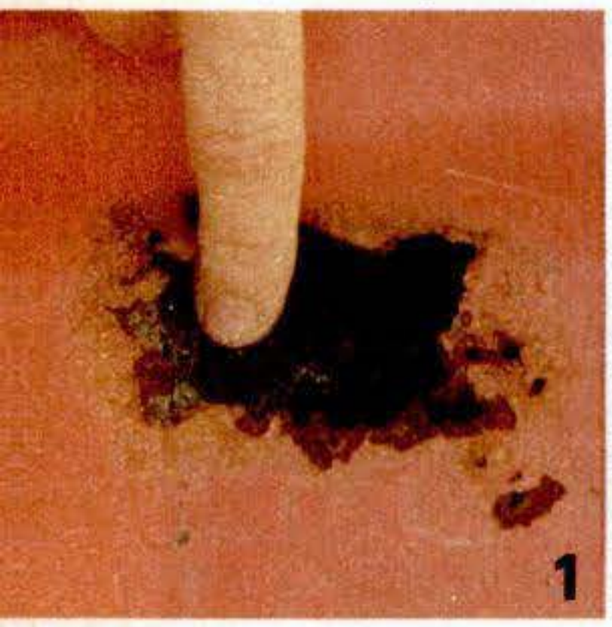
2 Grind the rust from around the hole with a 50-grit sanding disk. You can remove the corrosion with an electric drill. But if you have access to an electric or air-powered grinder, the job will go faster. Be patient. Sand until *all* traces of the rust are gone.

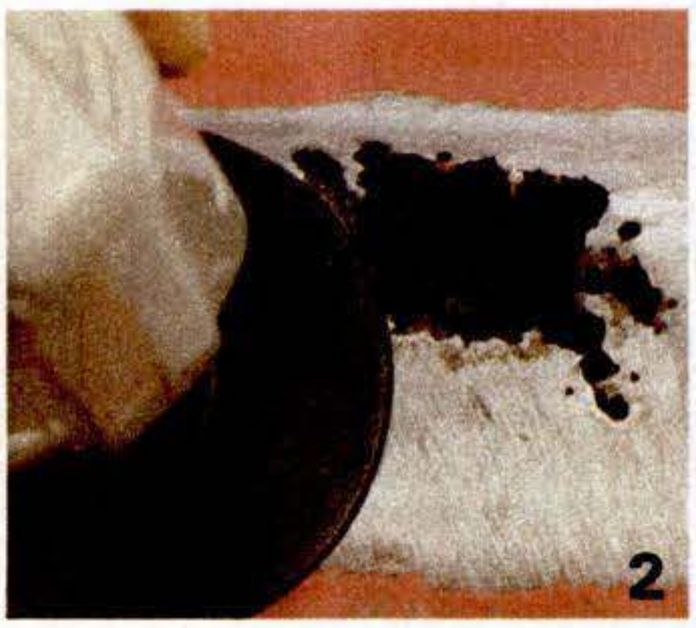
3 After sanding, beat the metal inward around the edge of the hole so that it's at about a 45-degree angle.

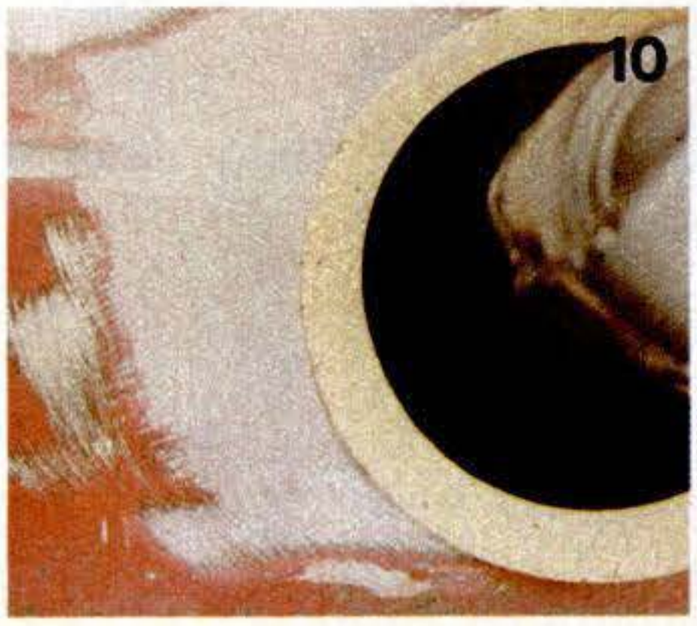
4 Cut a piece of fiberglass screening slightly bigger than hole (this screening is available at auto-parts stores, as are all other supplies mentioned). Put the screening aside for later use.

5 Use body filler to form a ring around the hole as shown. Smooth the filler with a rubber spreader. If the spreader doesn't come with the filler, you can buy one for about 50 cents. When the spreader loads up with body filler, just bend the scraper and peel the filler off.

Repairing rusted-out holes in sheet metal







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The fix? A visit to your local body shop, which can take a nice bite out of your checking account. Or make the body repairs yourself.

To give you the best possible advice on doing the repairs yourself, I went to Solon, Ohio, to visit Ray Uhl. Ray has been in the body-repair business 13 years. He's a partner in Solon Auto Body, a shop that has a reputation for doing first-class work.

Not too surprisingly, Ray started by telling me that the average do-it-yourselfer should not be disappointed when he finishes his body-repair job and it doesn't measure up to professional standards. "That's not to say," he explained, "that the average guy can't make satisfactory body repairs. But there's no way he's going to fix, say, a rust hole, and end up with a job that will look as good as if it was done at a professional body shop. He just doesn't have the experience, knowledge, or equipment.

"He should also use common sense in deciding what repairs he can make," Ray said. "Major collision damage, serious rust where, say, half a fender is eaten away—this is beyond his ability. He's only going to get in trouble if he tackles major stuff like this. Minor scratches, dents, rust, chipped paint—sure, he can do this. It probably won't look as good as if a pro did it. But it'll look a heck of a lot better than if nothing at all is done."

Continued

6 While filler is flexible, put the screen you have cut in place. Just push it through the filler down against the metal. Let the filler harden before going to the next step. Don't let it harden on your fingers, though. Wipe the filler off your fingers with a rag unless you want an extra layer of skin.

7 After filler hardens (instructions with the filler will tell how long it takes), plug the hole with more filler. The screen forms a container to hold the filler while it hardens. Use your rubber spreader to smooth the body filler to the contour of the surrounding metal. If you've ignored steps 4-6, just plug the unscreened hole with filler.

8 Form the body filler to the same contour as the surrounding metal, and also spread the filler so it smoothly meets the adjacent metal. That means many smooth strokes with the spreader. As the spreader loads up, clean the filler from it for maximum smoothness in spreading.

9 When the body filler is almost hard, use a knife to do more contour shaping. You could wait until the filler dries and finish shaping with a sander, but a knife saves time. Point the knife's cutting edge away from you.

10 Use a 50-grit disk to sand the filler after it hardens. Sand until it's flush with the surrounding sheet metal.

11 If there are any folds in the metal, as in the fender here, roll two sheets of 50-grit paper together (the two sheets reinforce each other, and their naturally round shape when rolled together fits the contour of a fold nicely) and sand the filler to the proper shape. Then put on another layer of body filler to smooth out the imperfections in the first coat. When this layer dries, use an 80-grit disk and 80-grit paper (to sand any folds) and sand as before. The sanding will take time. Again, be patient.

12 Apply a thin layer of spot putty over any minute imperfections, following maker's instructions. Let it dry.

13 Sand with 80-grit paper until smooth. When hand-sanding, press four fingers evenly against the sandpaper. After sanding, wipe the area clean with a dry rag.

14 Spray the area with primer. Feather the primer onto the original car paint. Let the primer dry.

15 Hand-sand the primer with 320 or 400 paper. You don't have to sand a lot—just enough to rough up the primer slightly for good paint adhesion.

16 Now paint with appropriate color. Use enough coats to cover the primer. Let the paint flash-dry (two to five minutes) between coats. After the final coat dries (allow at least two days), rub the paint out with hand-rubbing compound according to instructions on the can. For a more professional job, rub out the whole panel. For example, if you filled a hole in the fender, do the whole fender. This blends the old and new paint better. Also remember that as the fresh paint ages and fades due to weather, the new paint will blend even more with the old. But as we have pointed out, don't expect a perfect paint match if you use an aerosol can. Chances for this are slim.

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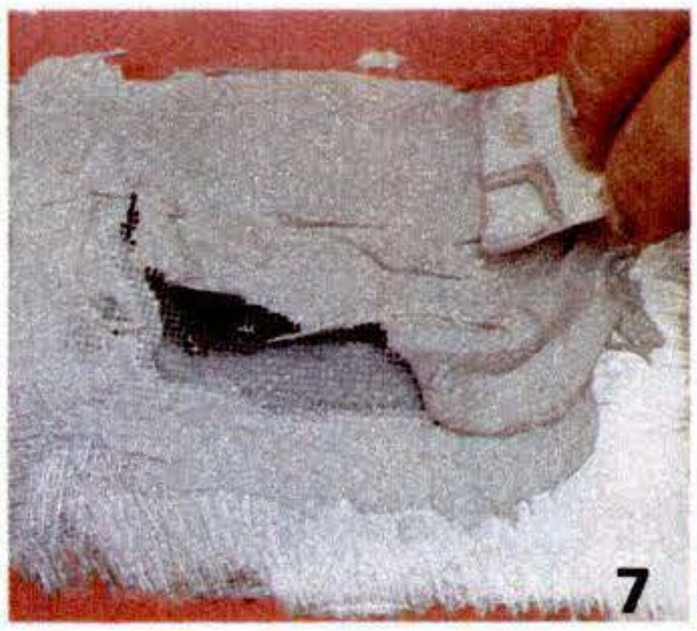
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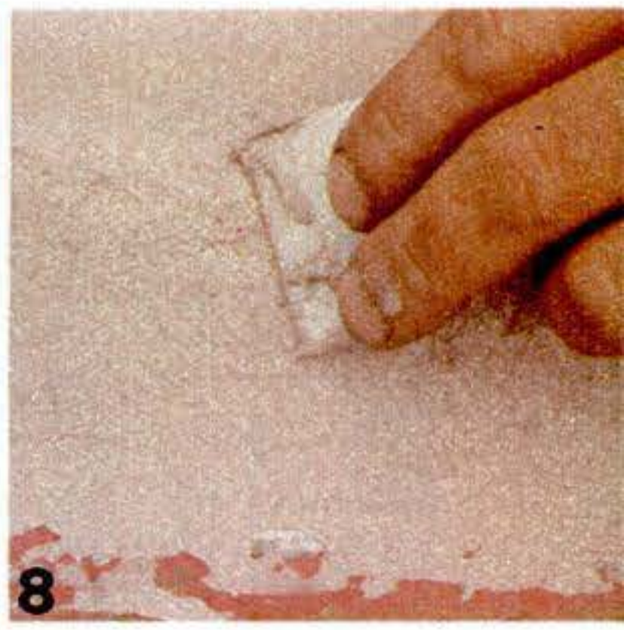
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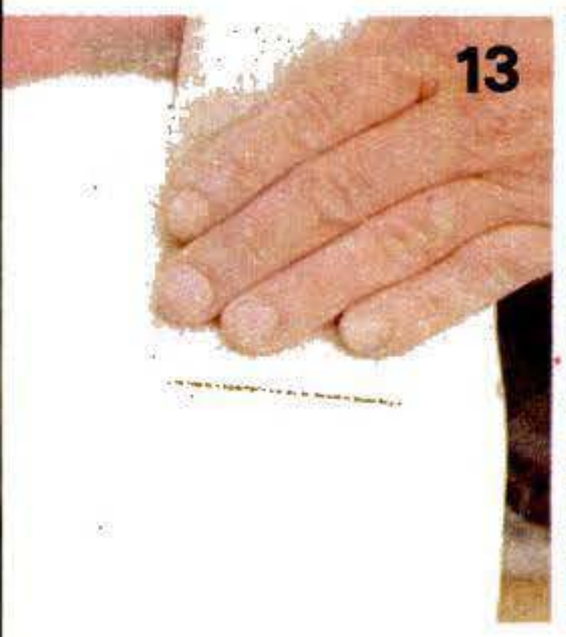
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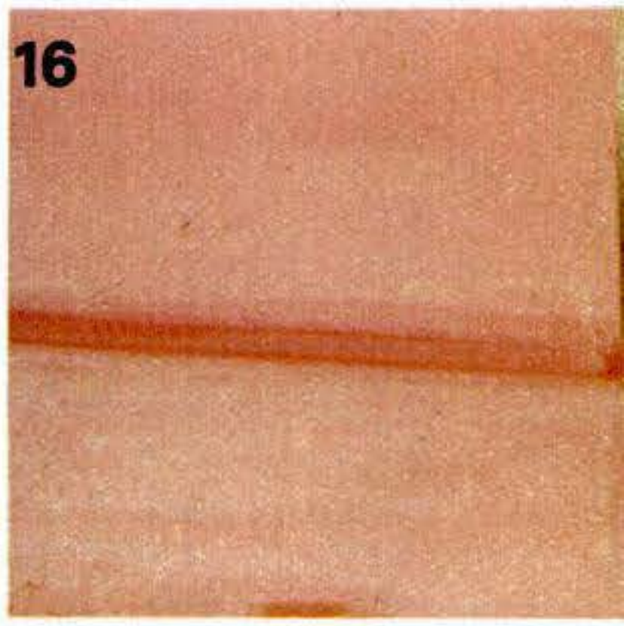
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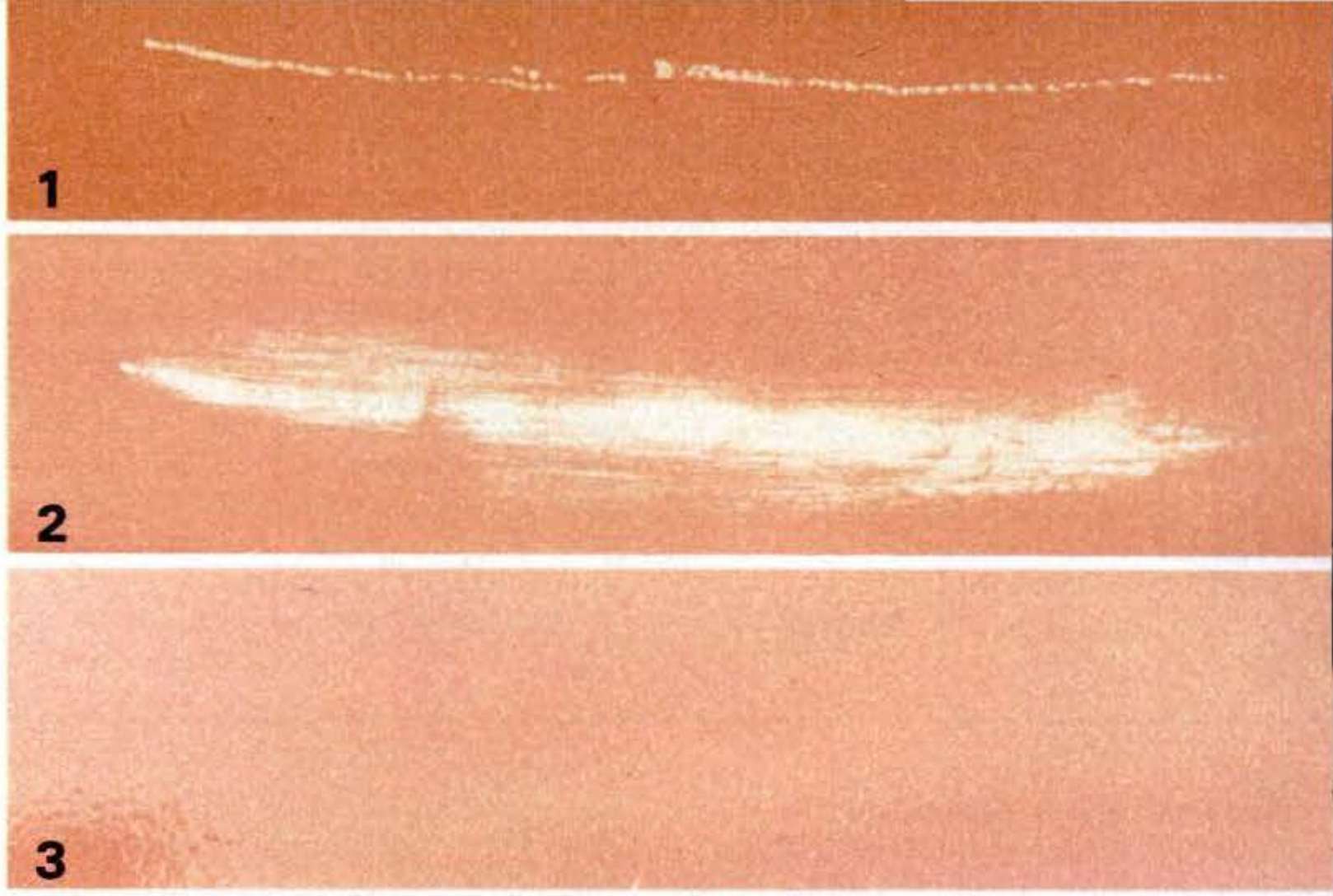
Repairing scratches



1 This is a deep scratch. It extends to the primer but does not go through to the metal.

2 Start the fix by sanding with 400-, 500-, or 600-grit paper until the scratch disappears. Then paint. If the scratch extends into the metal, sand the scratched area smooth and apply primer. When the primer is dry, sand with 320 or 400 paper. Then paint.

3 Let the paint dry for two or more days, then rub the area out with hand-rubbing compound. The finished job should look like this, but you may not be so lucky: Finding an aerosol paint that matches so well is chancy.

Repairing an area plagued with chipped paint

1 Chipped paint often looks like this. Rust has already set in. If allowed to continue, corrosion will eventually cause a hole in the metal. Prompt repair can avoid deep rusting.

2 Remove the rust with 80-grit sandpaper. Use one finger to press down on the area you're sanding. Sand down to bare metal. Then prime the area. When the primer is dry, sand only the primed area with 320 or 400 paper. Then use rubbing compound to rub the painted area around the primer.

3 Sand the area immediately surrounding the primer with 600 sandpaper. Sand just slightly into the edges of the primer, but don't sand the primed area itself. Then paint.

4 Let paint dry for two days or more, then rub out painted area and surrounding old paint with rubbing compound to get a better paint match.

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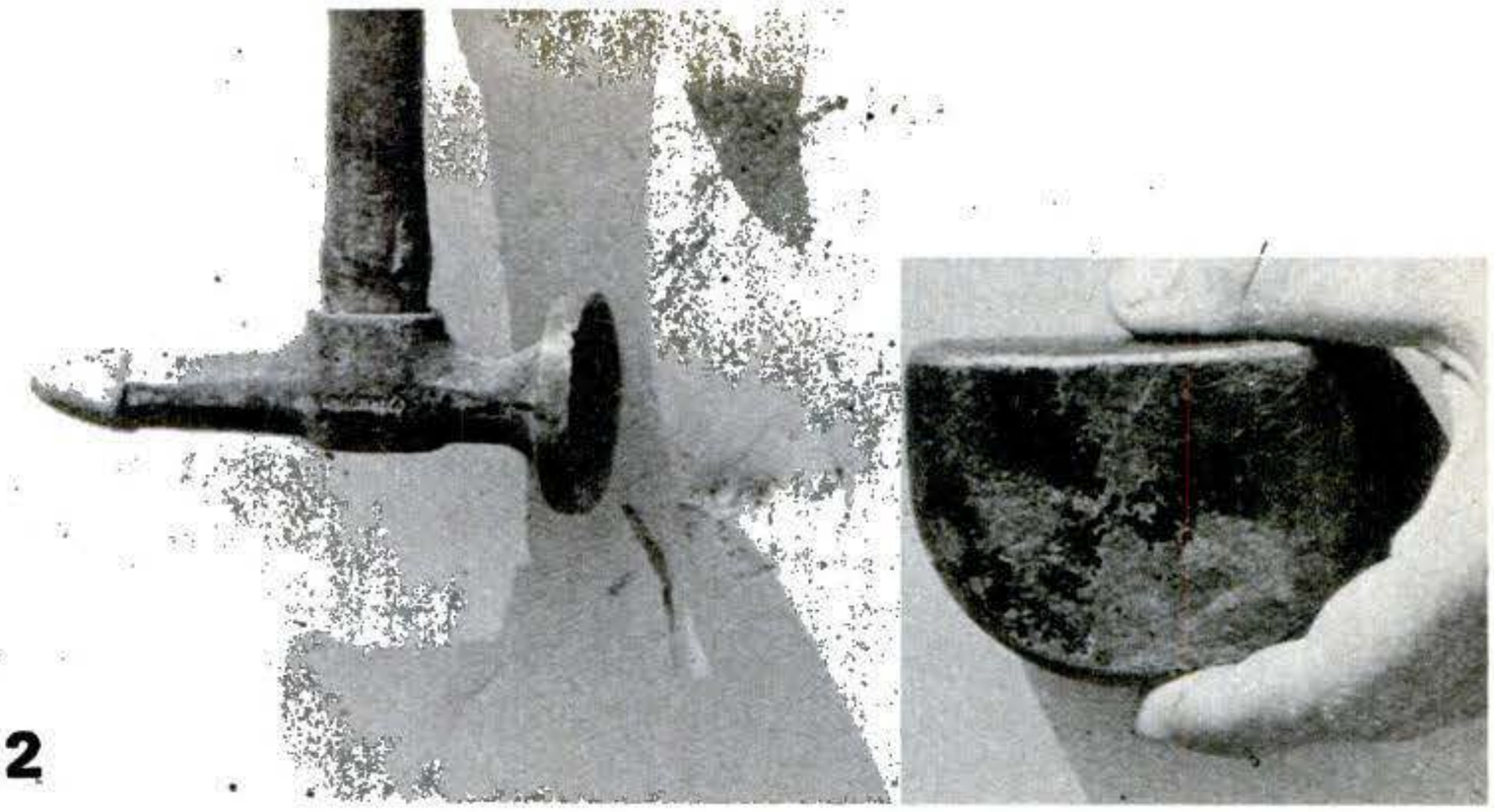

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Repairing dents

1 Minor dents like these can be knocked out with a body hammer.

2 Use a dolly with the hammer. These tools are available from some mail-order houses and also in many automotive-parts stores.

3 Use either end of hammer—whichever gives better results. Sometimes, putting the dolly behind the metal (where possible) while you strike it works best. When you have made the dent as smooth as you can, sand it to bare metal with a 50-grit disk on an electric drill or grinder. Then fill depressions with body filler (steps 7-16 of the rust-repair sequence).

4 Let paint dry for at least two days, then rub the area with rubbing compound.

A minor scratch is the easiest job to tackle. That's a scratch that doesn't penetrate the outer layer of paint. All you need here is a clean soft cloth and rubbing compound. Just put some on the cloth and rub until the scratch disappears.

Rubbing compound is also useful for restoring luster to faded paint. Just follow the instructions on the can. But remember, Ray cautions, to use only enough compound to get the job done. It's abrasive, and excessive rubbing actually takes off the thin layer of paint that covers the primer.

When a repair requires primer and paint, you can buy both in spray cans at your local auto-supply store. But you won't get a perfect match using an aerosol paint. You probably won't even get a good match, Ray says.

One reason is that the paint on your car has faded due to exposure to the weather. Another, in basic terms, is that the paint in the aerosol cans isn't mixed to the exact specs of your car's paint. Ray overcomes this obstacle by mixing his own paint. This, plus things like being able to control air pressure at the paint gun, enables him to get a perfect, or near perfect, match.

There is a partial answer to this problem for the do-it-yourselfer. After the paint has dried for at least two days, rub the freshly painted area as well as the surrounding area with rubbing compound. This helps to blend the old and new paint shades together. (With enamel paints, wait at least 30 days before compounding the newly painted area.) Another answer is to do all the body repair yourself, up to the point of adding paint, then let a body shop take over. It will be less expensive than if they did the whole job, and you'll get a better match.

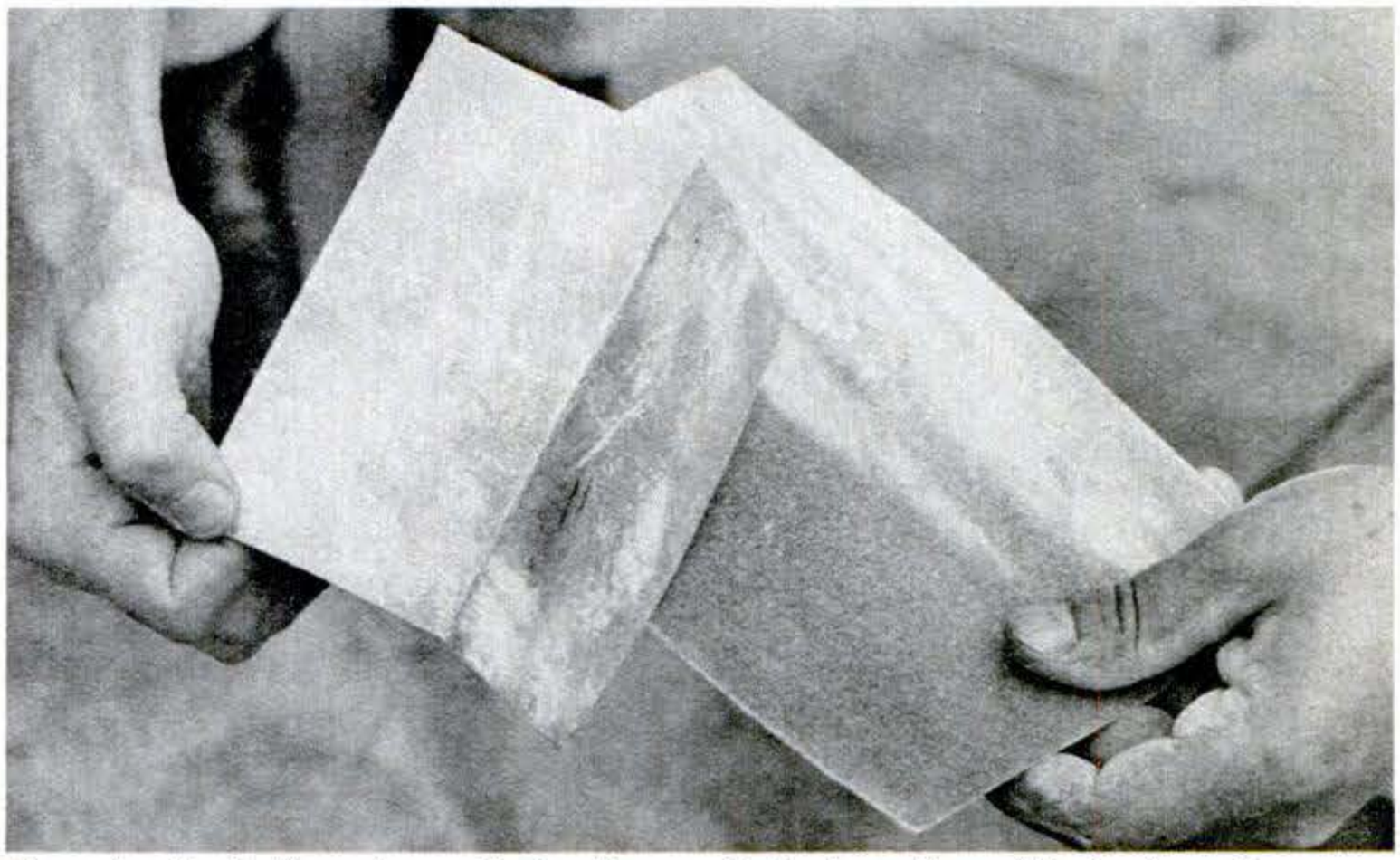
The accompanying photos and captions show how Ray advises the weekend mechanic to repair rusted holes, minor dents, scratches that penetrate the outer layer of paint, and chipped paint. If, when painting, you get a run, or dirt gets in the paint, let it dry for a couple of hours, then sand out the run or dirt with 400 sandpaper and repaint.

Another tip: After sanding, make sure the area you're going to prime or paint is absolutely clean. One way to do this is by rubbing with a tack cloth. The cloth costs 45 cents or so and is specially made to pick up all dust and lint from metal, primer, or paint.

If you have never used an aerosol can for painting, it's not a bad idea to make a few practice strokes on a newspaper or piece of scrap metal—just to get a feel for using the can.

When using spot putty, use as little as necessary. A thick layer of spot putty will later crack, spoiling your job. PS

Making your sandpaper last longer



To make sheet of sandpaper last as long as possible, tear or cut it in half, then fold each half into three sections. You effectively end up with six pieces from one sheet—and save paper and money as well as time.

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Sun power makes window greenhouse self-ventilating

New materials let you build this plant bay better and cheaper than ones you buy

By GREG STONE

Ten years ago, I built my first window greenhouse. I did everything wrong. The unit was built of the wrong materials, it was too large, and ventilation was inadequate. To top it off, the thing leaked.

In short, I learned the hard way. This year, I applied these tough lessons to a new window greenhouse and the results are satisfying indeed. It turns an ordinary window into a beautiful plant palace. And, as I write this, a storm is blowing cold rain against the greenhouse, and none is

Continued

Light flooding in from the window greenhouse makes the room cheerier (left). The automatic ventilator in the top left corner of the unit is necessary—without it, the small volume of air in a window greenhouse responds too quickly to outside temperature changes. The greenhouse is fitted snugly against the old window frame (top) for a weathertight seal.

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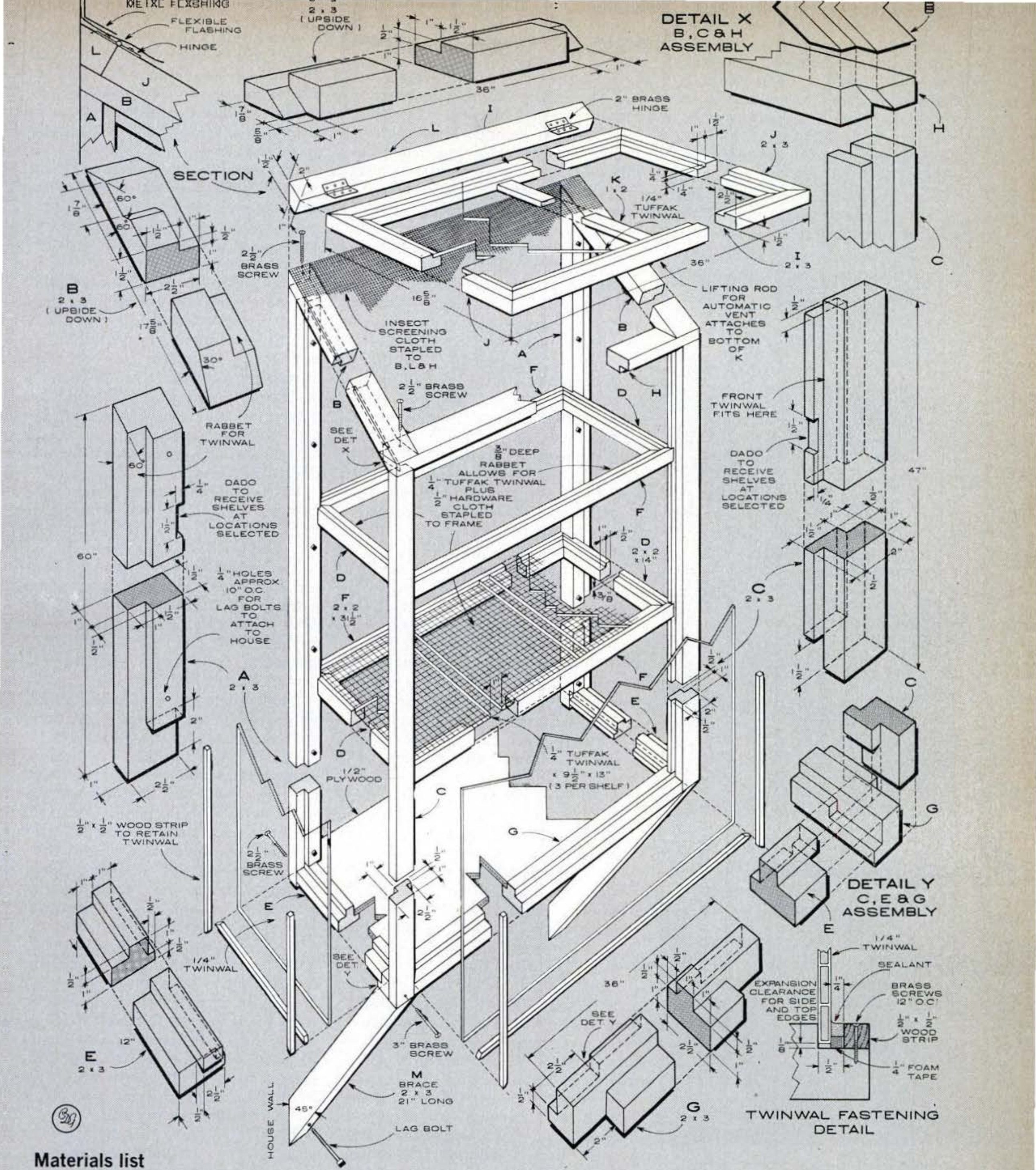

Materials list

Wood

Part	Size	Length	Buy
A	2 x 3	5′	2
B	"	4′	1
C	"	4′	2
E	"	3′	1
G	"	3′	1
H	"	3′	1
I	"	6′	1
J	"	3′	1
M	"	4′	1
D	2 x 2	5′	1
F	"	6′	1
L	"	3′	1
K	1 x 2	1½′	1

½-inch outdoor plywood, 18"x36" for bottom

Hardware

1 Solar Vent (Dalen Products, Inc., 201 Sherlake Dr., Knoxville, Tenn. 37922)
2 2" brass hinges
3′ metal flashing
3′ flexible flashing to cover hinge area
½ lb. 6d galvanized finishing nails
¼ lb. 12d galvanized finishing nails
2 3" brass flathead wood screws
4 2½" brass flathead wood screws
14 3"x¼" galvanized lag bolts
50 #6 1" flathead brass or cadmium-coated screws

Other

4′x8′ sheet Tuffak-Twinwal (for nearest dealer write: Rohm and Haas Co., Independence Mall West, Philadelphia, Pa. 19105)
1 tube GE Silglaze, or similar silicone sealant
54′ ¼" foam weather-stripping tape
1 small can waterproof glue
2′x3′ ½-in. mesh hardware cloth
16⅝"x36" insect screening for vent

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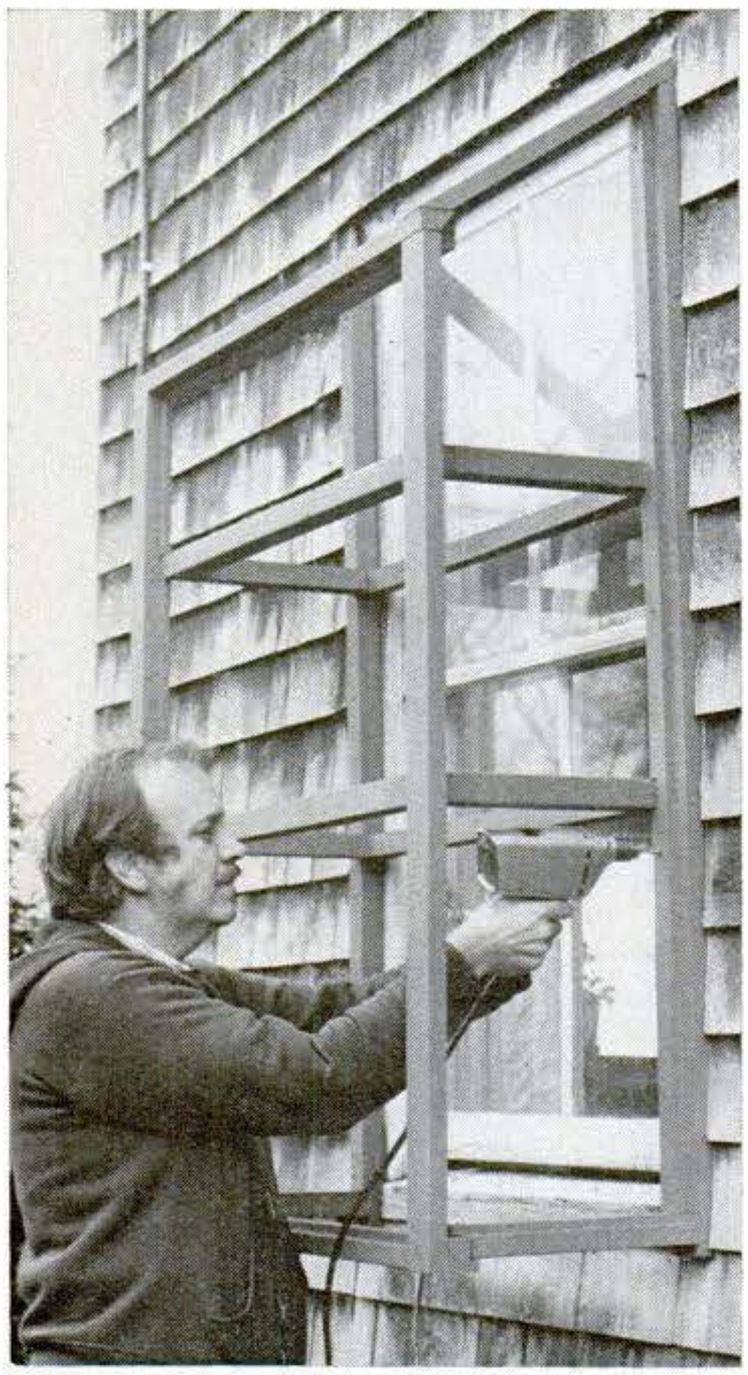
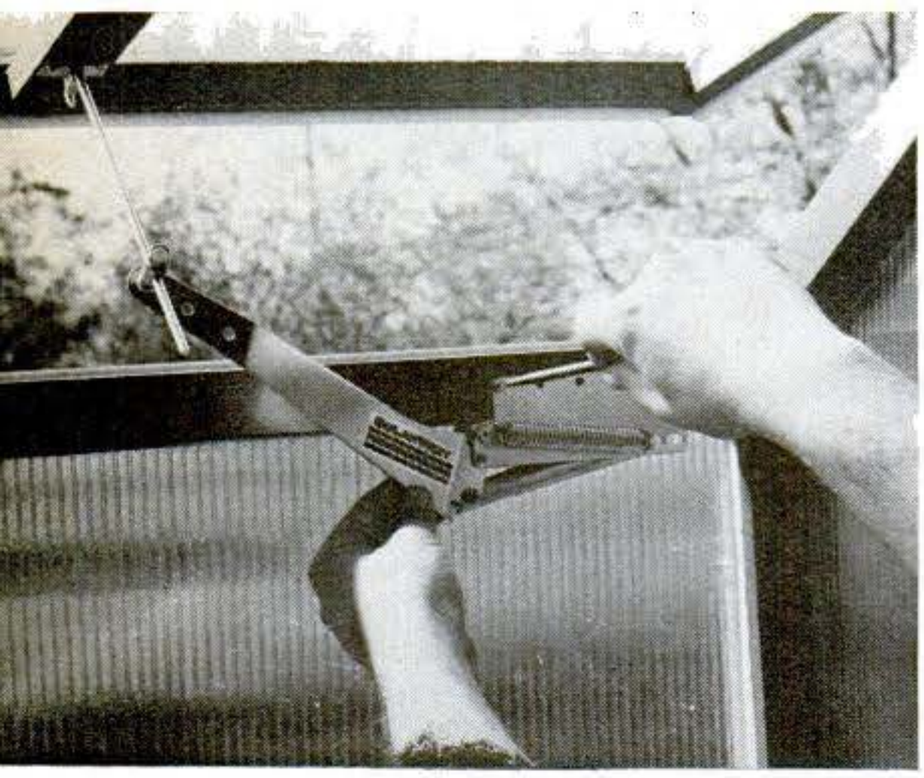
leaking in—the room remains cozy.

The project can be completed comfortably in two weekends at half the cost of a comparable aluminum-and-glass window greenhouse kit.

But what really set this greenhouse apart are the automatic ventilation and the glazing. Automatic ventilation may sound like a frill. It isn't. Without it, you must baby-sit the greenhouse or risk rapid temperature changes that can damage your plants.





Fasten greenhouse frame tightly to house (top) before inserting glazing and shelves. Energy-saving Solar Vent (above) responds automatically to temperature changes. When greenhouse air reaches 62° F, a chemical inside the cylinder heats, slowly forcing the cylinder to expand. This pushes the left arm up and opens the vent. It's wide open at 75°. When the greenhouse cools, the process reverses, and the cylinder contracts, pulling the spring back to close the vent. Loosening a nut on the lifting arm disengages unit entirely.

Most greenhouse ventilators are electric; many are expensive and require special wiring. The Solar Vent system I chose after spotting it in PS [What's New in Home Improvement, Dec. '76] uses sun power (see photo). It costs $25 postpaid, takes about 15 minutes to install, and has worked well for me.

The glazing is another energy-saving feature. Tuffak-Twinwal (I included it in my Sept. article, "New Glazing Materials") is two polycarbonate sheets bound with a dead-air space between them. According to its maker, Rohm and Haas, it gives up to 40 percent more thermal insulation than one layer of acrylic or polycarbonate sheet.

Twinwal comes in 4x8-ft. sheets and costs about $1.35 a sq. ft. With careful planning, a single sheet will provide both glazing and shelves. Just be sure you design the greenhouse so its outer wall is no more than 47 in. high and 36 in. wide. This should cover a typical window, as shown in our plans. If your window is slightly taller, fill in at the bottom with a baseboard.

Design the greenhouse so it will exactly match the dimensions of the outside window frame. This simplifies installation and lets you make a rain-tight seal to the house.

Though you can put a greenhouse on almost any window, it's easiest to install it on one near the ground. But choose a window that offers good growing conditions. South exposure is best; east is good; west, poor; north, very poor.

Plan shelves to accommodate your plant collection. The shelf frames (D and F in plans) are an integral part of the structure, but you can adjust them up or down a few inches, or add a shelf.

Shelving material should be strong, transparent, moisture-resistant, and allow free air circulation. I stapled mesh hardware cloth to the frames. This supports three pieces of Twinwal laid side by side with a one-inch gap between them.

For the framing, you can use rot-resistant or pressure-treated wood. Since a window greenhouse doesn't get as humid as a full-size one, I used pine painted with a linseed-oil-rich stain that will do some preserving. If you use a brush-on preservative, make sure it's a water-borne salt type. Creosote and similar oil-borne preservatives are toxic to plants.

Construction details

Do all the cutting first, making sure the pieces fit together as you go along. You can plan to spend the better part of a day just cutting all the rabbets and angles. All rabbets go the length of the stock, so you can do all dadoing first. Then make the angle cuts, and do the backsaw and chisel work.

To assemble the framework, first coat all joints with waterproof glue, then fasten with 6d or 12d galvanized finishing nails, as appropriate. Also use brass wood screws to fasten major corner joints.

Start with the shelf frames and set them aside for the glue to dry. Then go to work fitting sides B and E to vertical members A and C. Attach brace L at top between rear uprights as shown, then tack on a matching temporary brace at the bottom to give stability. Next, attach the permanent front pieces, H and G. Finally, install shelf frames and paint the unit.

While the paint dries, remove the existing sash from the window. I boxed the inside frame with 1x6 redwood boards for a neat look.

To install the greenhouse, tack the framework temporarily in place against the window frame, then drill ½-in. holes through it and the frame. Insert lag bolts, make sure the unit is level, then attach the diagonal braces (M).

Next, install the glazing. Stick adhesive-backed foam weather-stripping tape to the edge of each Twinwal panel, fit the Twinwal in place, and screw in wood strips to hold it. Seal the Twinwal to the frame with silicone caulk.

For the lid glazing, fit the Twinwal in the rabbets and attach with brass screws and washers. Drill oversized holes for the screws to allow for expansion. Tighten the screws, then back off a half turn.

Seal any gaps between the finished unit and the house with liberal amounts of weather stripping and caulk. Install flashing along the top, including a flexible strip to cover the hinged vent area. (I used a piece of anti-scuff material designed to protect woodwork.) Put in the shelving, and staple a screen across the top of the unit.

Finally, install the Solar Vent according to manufacturer's instructions. Mount the ventilator's base on the inside of part H and attach the lifting rod to the underside of part K (see photo).

The heat from your home should be enough to warm the greenhouse in winter. The window unit may be slightly cooler than the room, but most plants prefer that kind of environment. They should reward your efforts with blooms and fresh growth right through the winter. PS

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Chisels and gouges

that work where power tools won't

They'll help you handle tough jobs, and make you feel like a sculptor

By A. J. HAND

There is no joy in woodworking that can compare with that of using a razor-sharp gouge or chisel. You can feel it in your hands as the tool glides through the wood. You can hear it as wood fibers yield with a whisper to sharpened steel. You can smell it as chips of tangy pine or fruity cherry pile up. You can see it as the tool leaves behind a wake of smooth, polished wood. It's enough to make you feel like a sculptor.

Sure, there are power tools that will do almost every job these hand tools can do, and do it faster. But there are times when nothing but the hand tool will do.

No home-shop drill press can handle the job of cutting monster mortises in heavy framing members. But a log-cabin chisel can.

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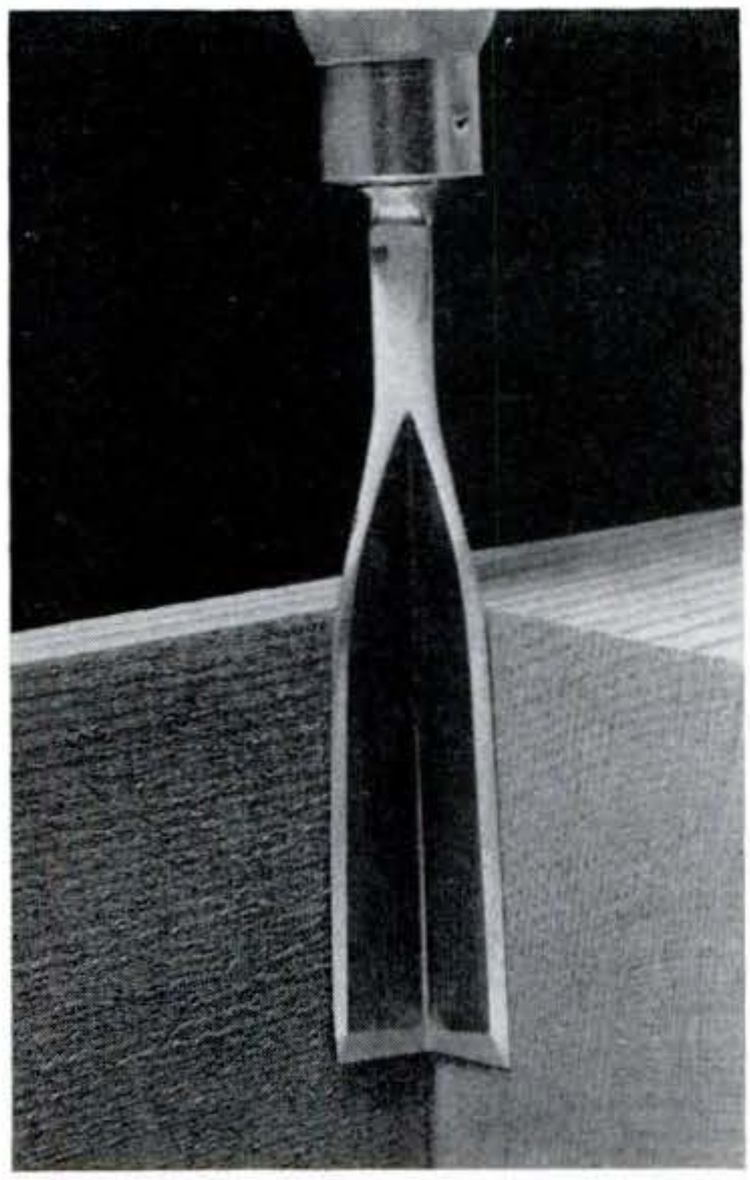
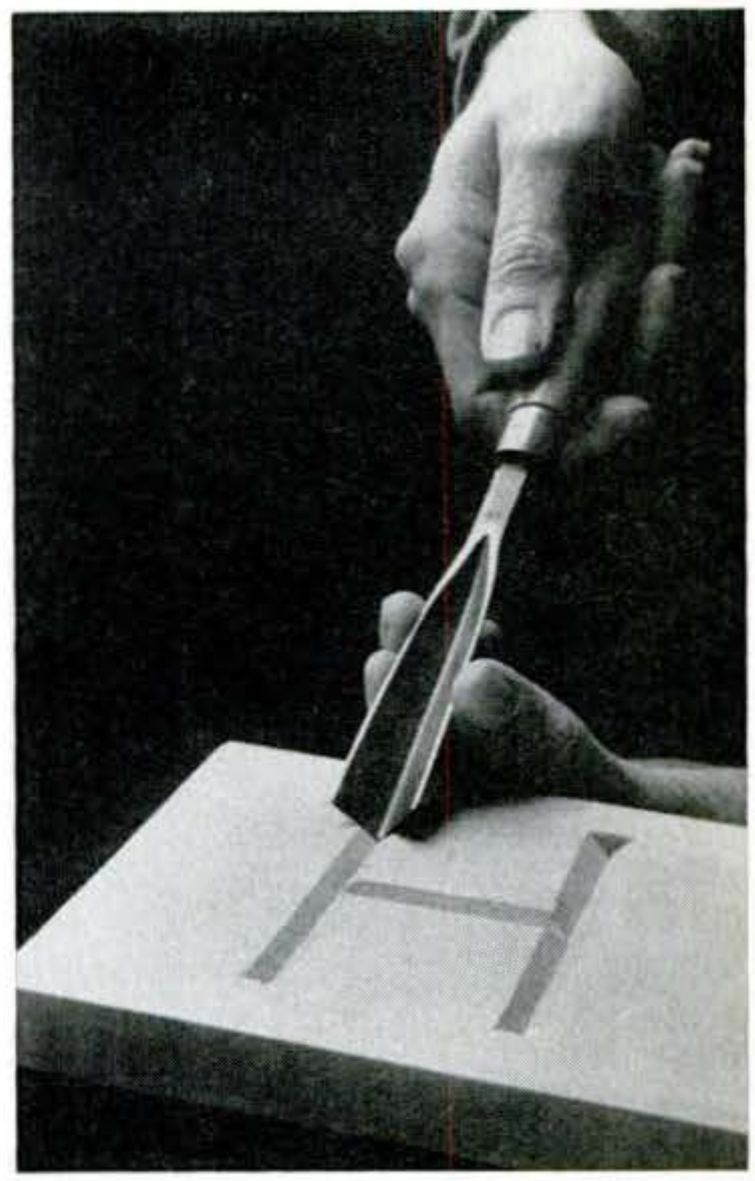


Cornering chisel is ground to a 90-degree angle on the outside; the cutting-edge bevel is ground on the inside for perfect corner cuts in mortise work.



Lettering chisel looks like a cornering chisel, but the cutting-edge bevel is ground on the outside. Use it to cut incised V-groove lettering for signs.

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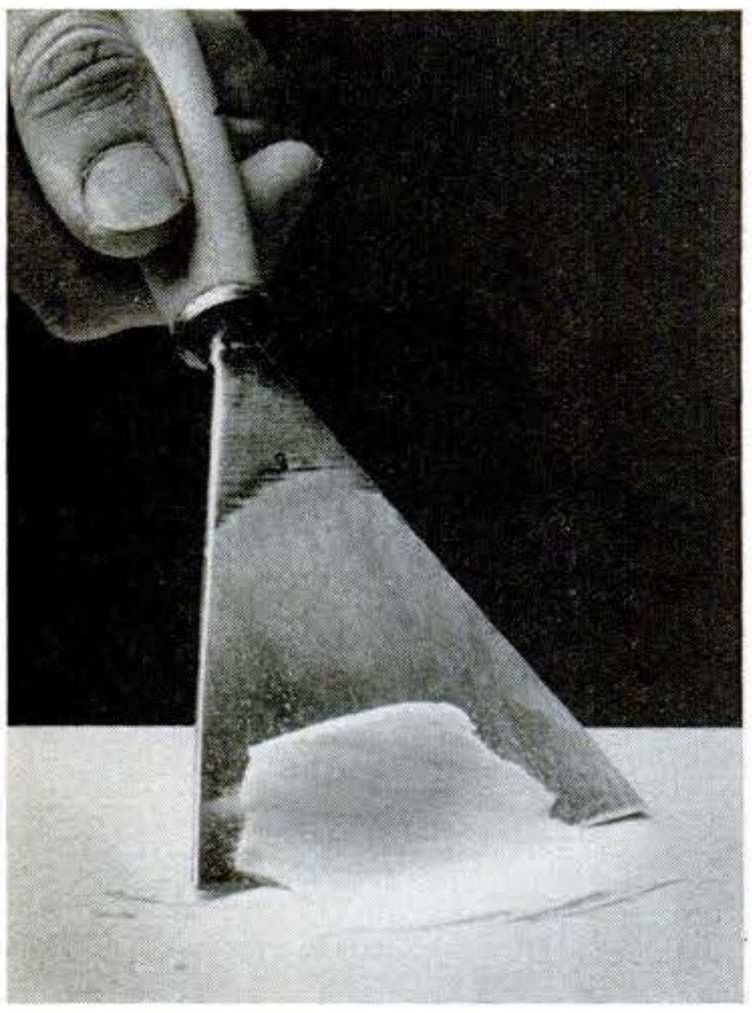
No router bit will cut a mortise with square corners. That's a job for a cornering chisel. Lettering? A router will do if you like your letters rounded at the ends, with no angular serifs, no variation in width, no character. If not, you'll want a lettering chisel, or a parting tool and a few woodcarving skews and chisels.

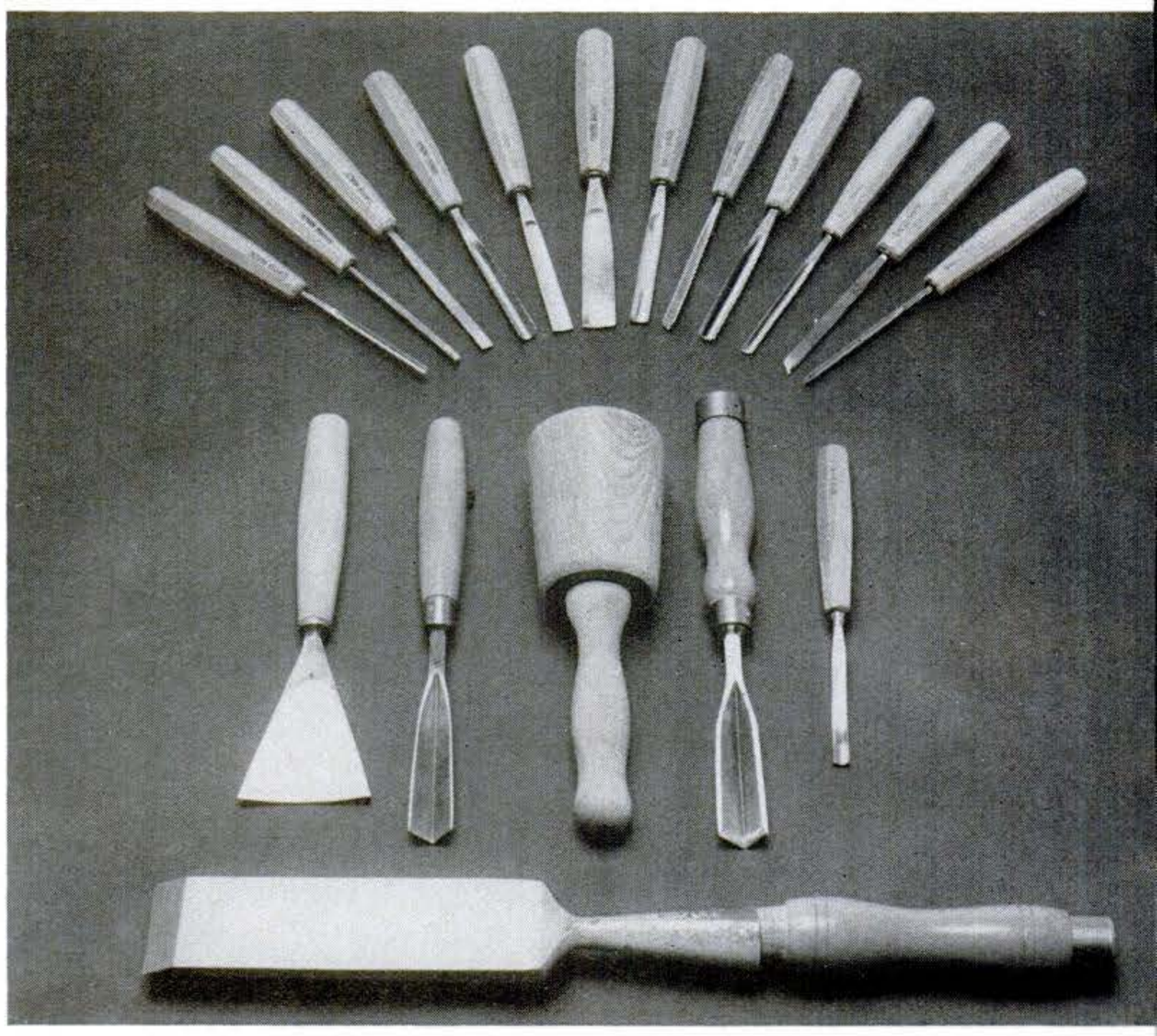
When I first bought my carving tools—those fanned out in the photo—I intended to use them only for bird carving. I soon found how useful they are for less artistic work —shaving miters for a better fit and cleaning up rough dadoes cut with power tools.

That led me to add to my collection the special-purpose tools shown here. Now I wonder how I ever got along without them.

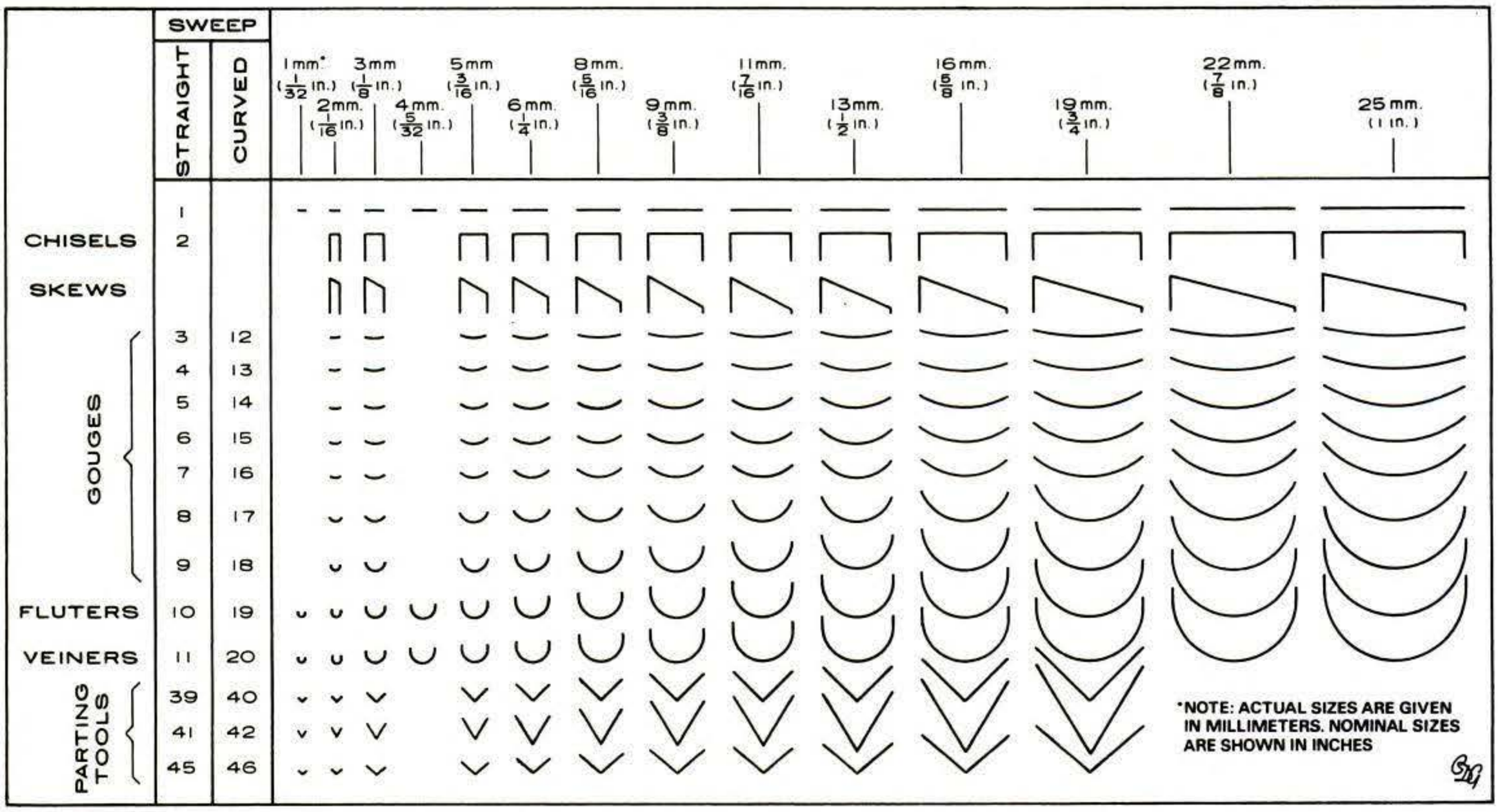
Don't get me wrong. I'm not about to throw out my power tools. But how can I turn my back on these hand tools? They do their work and do it well, without whining motors or whirling electric meters. And they make me feel like an artist in the bargain. PS



Extra-wide fishtail gouge is great for removing wood from large areas. Its shallow sweep keeps corners from digging in; shape gives good visibility.



Woodcarving tools at top of photo are designed for the artist, but have plenty of home-shop applications. Other tools and mallet are for heavier work.



Carving tools are described by a universal system of numbers and letters. First one or two digits describe curve or sweep. Note that sweeps of curved-shanked tools are numbered differently from those of straight-shanked tools.

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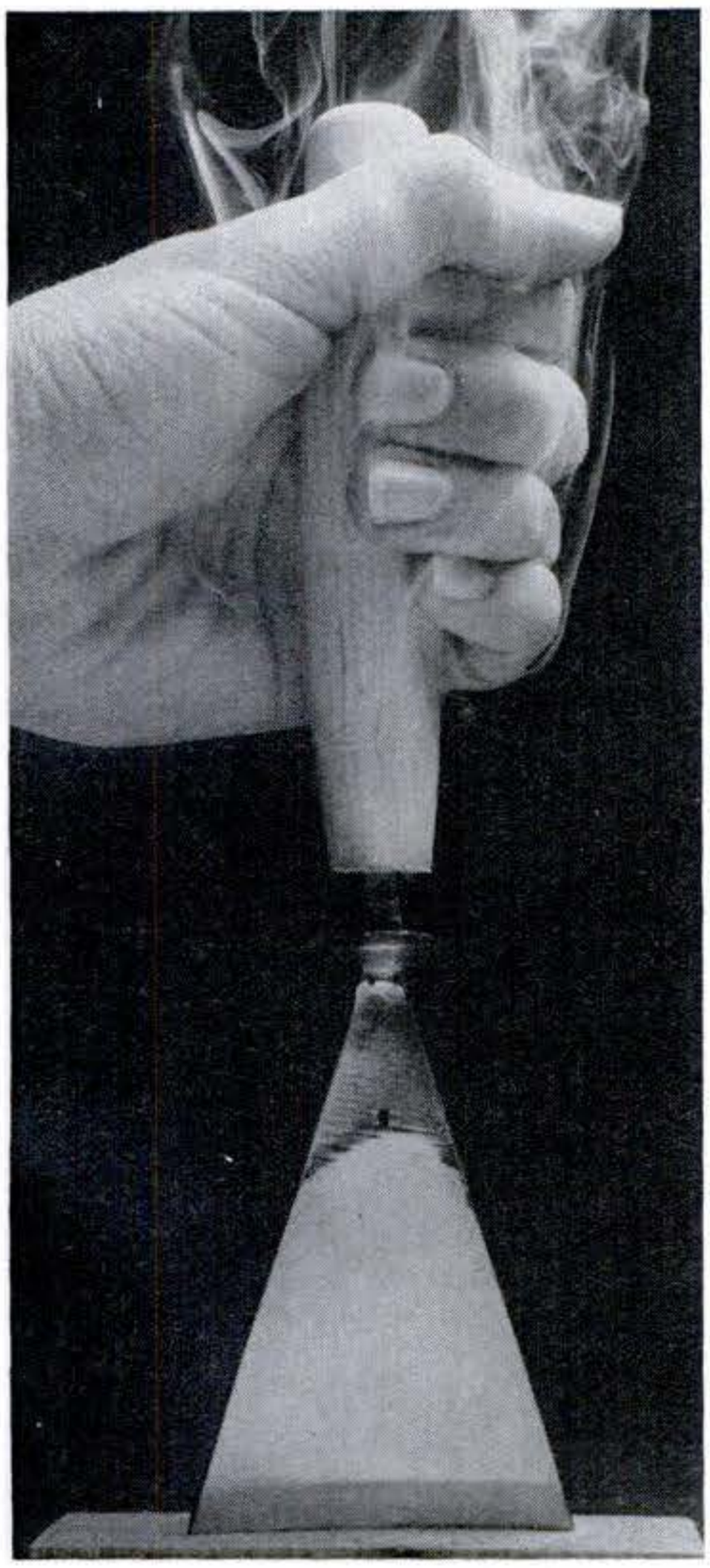
WHERE TO GET THEM

Frog Tool Co., Ltd., 548 N. Wells St., Chicago IL 60610. Tools and sharpening stones. Catalog is 50¢.

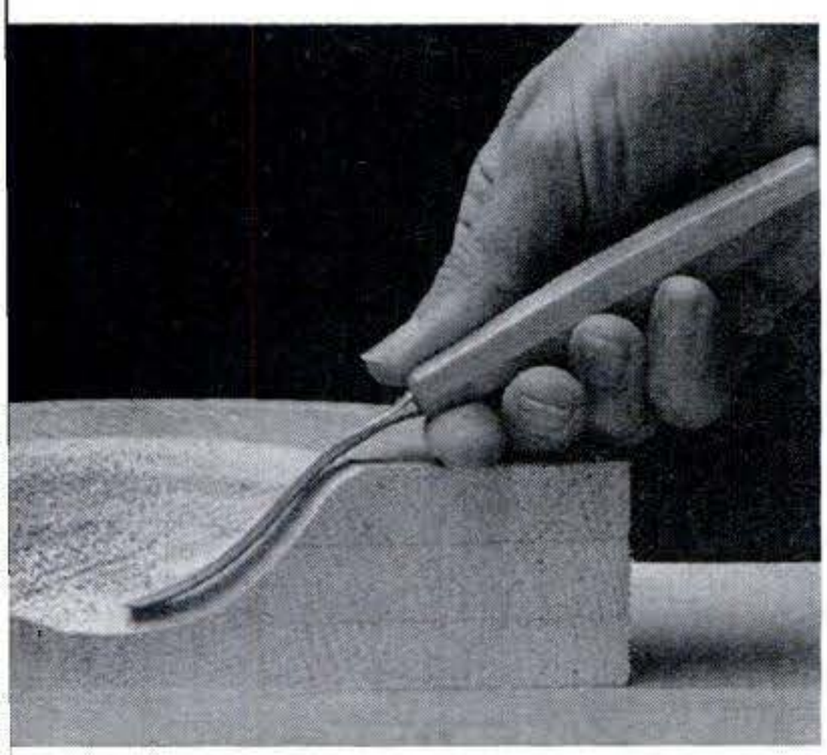
Garrett Wade Co., Inc., 302 Fifth Ave., New York NY 10001.

Brookstone, 125 Vose Farm Rd., Peterborough NH 03458.

Woodcraft Supply Corp., 313 Montvale Ave., Woburn MA 01801. Tools and sharpening stones. Catalog is 50¢.



Handles don't come with all tools. Make your own from hardwood, drill an undersize hole for tool's tapering square tang. Heat tang red hot, force handle on.



Bent-shank gouge gives you the clearance you need to work into deep depressions. A straight-shank gouge would dig in if you used it for such work.

Chisels and gouges: how to get and keep them razor sharp

Chisels and gouges work best only when they are literally razor-sharp. Many tools come ground to the proper bevel, but they still require careful honing and stropping to bring them into peak working condition. If you are not a skillful sharpener, consider buying only presharpened tools, or take advantage of Woodcraft's sharpening service at a buck a tool.

My favorite stones are Washita and Soft Arkansas. Both are soft enough to cut fast, yet leave an edge keen enough for final stropping. And they are very easy to get the feel of. Trouble is, you can't buy V-slips for parting tools in this material. Here I fall back on my second choice, India stone.

Harder stones such as Hard Black or Hard White Arkansas can produce a slightly finer edge than any of the stones mentioned so far. But they are expensive, and difficult to get the feel of. Besides, once you strop, the advantage these harder stones have over the softer ones all but disappears.

Use plenty of honing oil on your stones. On straight-edged tools such as chisels, move the tool edge-first along the stone, as if trying to cut off a shaving of stone. Spread your work out over all parts of the stone so you won't wear a low spot in the middle. Start with medium pressure on the tool, then ease up for the last few strokes.

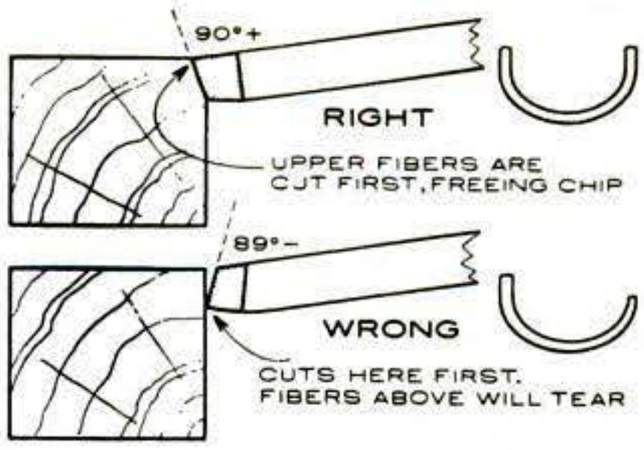
Use this same motion when sharpening parting, lettering, and cornering tools. You'll probably find it easier to move the stone rather than the tool when honing inner bevels.

Sharpen the outer bevel on gouges by drawing the tool backward over the stone while rocking it to assure all parts of the curve contact the stone. Sharpen the inner bevel by drawing the slip toward the tool's handle. Round the bevel slightly by varying the angle of the slip a bit as you draw it over the tool.

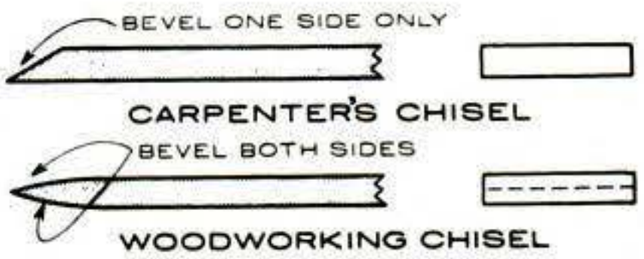
No matter what kind of tool you are sharpening, stop honing when the tool is sharp enough to shave the hair off your arm. Further honing will dull it.

Now it's time to strop. The easiest way to do this is to polish the tool on a buffing wheel charged with a buffing compound like tripoli. Hold the tool so the wheel rotates away from the cutting edge. Buff lightly for a second or two on one side of the tool, then flip it over and buff the other. Repeat once more, and the edge should be razor-sharp.

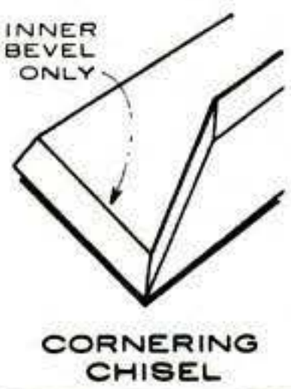
The buffing wheel works fine on chisels and relatively flat gouges, but it won't fit into the inner bevels on parting tools, or small-radius gouges and veiners. To strop these tools you can use strips of leather charged with crocus powder. Contact-cement the leather to a block of wood for stropping inner bevels in straight-edged tools. Bend the leather to the proper radius to fit inner bevels in gouges.



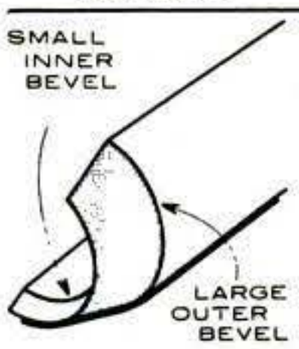
Woodcarving gouges should not be sharpened with an undercut (bottom). In use, a tool sharpened this way will tear chips loose. Properly sharpened tool (top) slices chips.



Carpenter's chisels are sharpened with bevel on one side only. Woodworking chisel has slightly rounded bevels on both sides so it cuts like a knife.

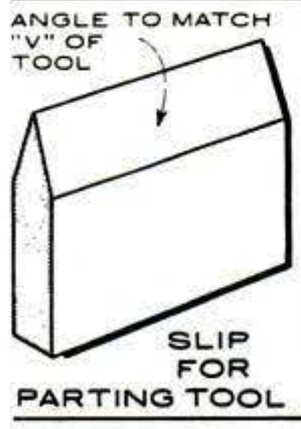


Cornering chisel is sharpened with bevel on the inside only. This leaves outer edge at perfect 90-degree angle and lets outer surface ride flat against the work.

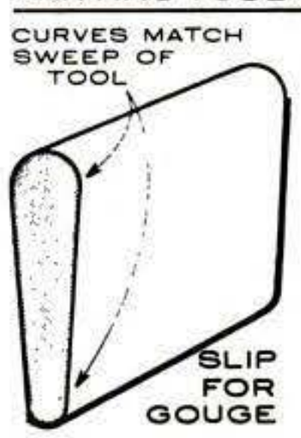


Gouges are sharpened with a large outer bevel and a smaller inner bevel. The inner bevel lets you use tool upside down to form raised beads.

Lettering and parting tools have both inner and outer bevels. If a hook appears during sharpening, remove it by rounding point of V slightly with a slip.



Slip for parting tool should match the tool's V. Use slips of India stone for preliminary honing, then work the bevels with Hard Arkansas before stropping.



Slip for gouge should match the curvature of the tool. Gouge slips are available in Soft Arkansas stone. These cut fast, leaving edge ready to strop.

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Install your own **water softener**

You'll end hard-water scale in your home's plumbing and get more mileage from soap

By RICHARD DAY

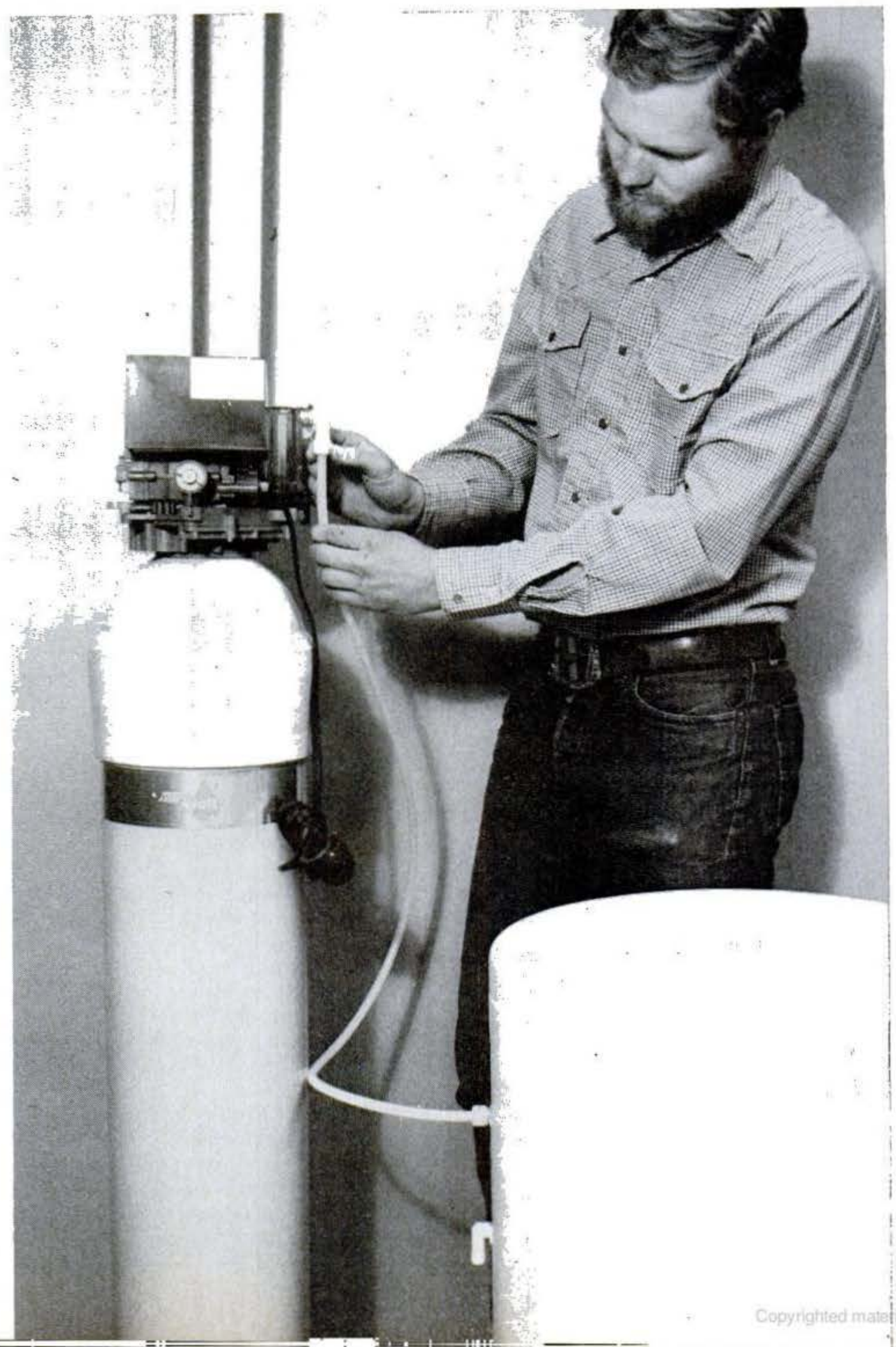
In the October issue we told you about a new type of water softener. This month PS surveys the field in general and tells how to choose and install the best softener for your home.

Rare is the household water that cannot be improved by softening. By ion exchange, the modern water softener removes bad-acting calcium and magnesium ions from hard water and replaces them with soap-compatible sodium ions. The hardness ions are flushed away during resin-bed regeneration. Soft water uses less soap and leaves no soap scum or pipe scale.

Is your water hard enough to need softening? Test it by filling two glasses, one with tap water, the other with bottled distilled or deionized water. Put five drops of liquid dishwashing detergent in each glass, cover, and shake. Then compare the suds layers: If your tap water doesn't match up, it isn't zero soft. Next see how many multiples of five drops it takes to create the same suds layer as in the deionized water. Ten drops? Twenty? Fifty? That's getting really hard.

Your water-utility or softener dealer can tell you exactly how hard your water is, measured in grains per gallon (gpg) or parts per million (ppm).

A hardness of five gpg brings undesirable dissolved solids similar to what a five-grain aspirin tablet would do if dissolved in a gallon of



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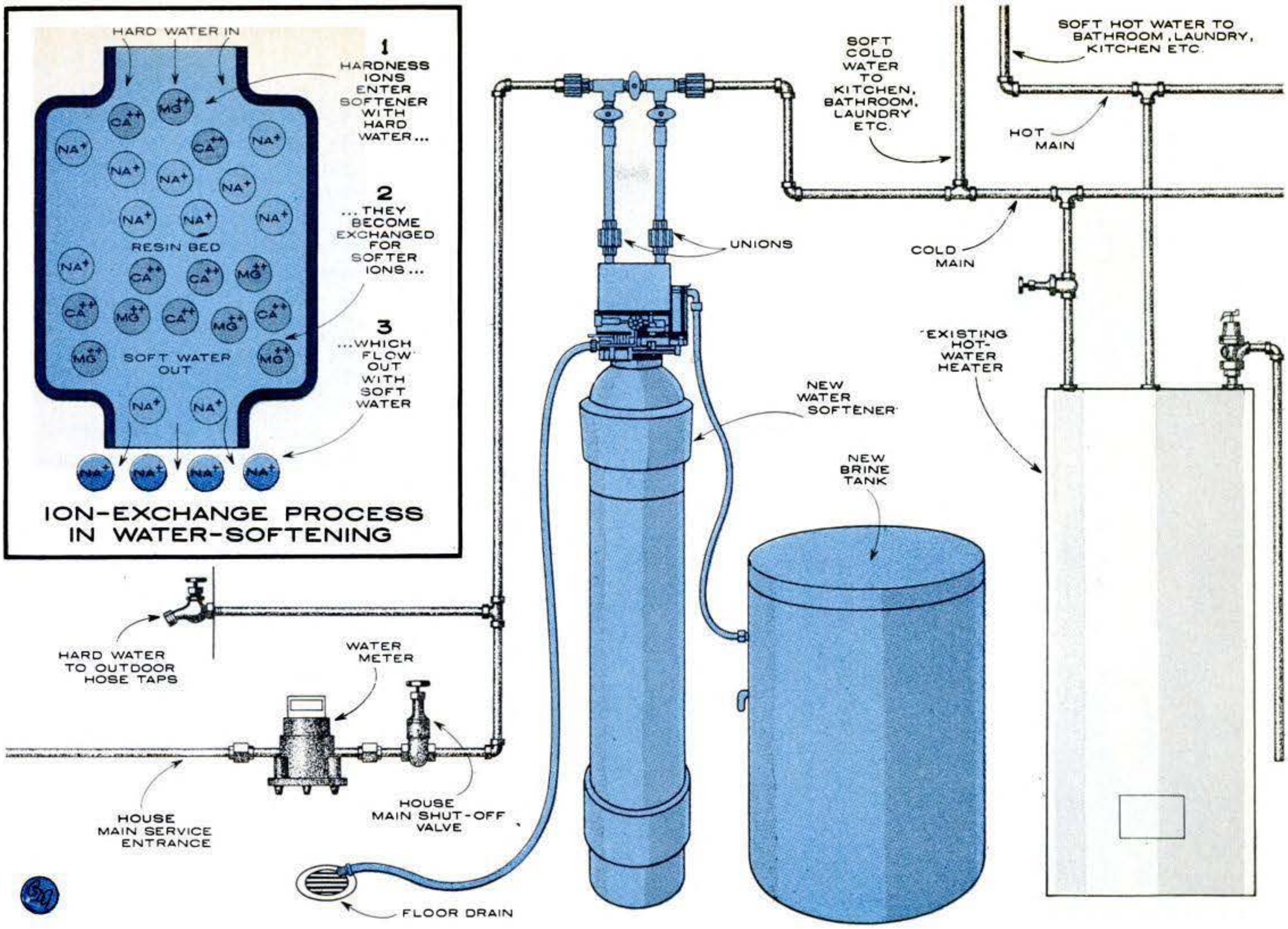

water. If your water doesn't rate either *soft* or *slightly hard,* it could use softening. Hardness above one gpg costs you money as well as cleanliness.

Of the ways you can get home-style soft water, the DIY-purchased-and-installed water softener is cheapest in the long run. Have your dealer help you select the size and price of softener that's best for your needs.

Some units are manual, costing less than $200. Semiautomatic softeners, costing more, shut themselves off but you have to start them. For up to $500 you can get a fully automatic water softener to which you merely add softener salt as it becomes depleted. The very best automatics use water sensors to tell you when regeneration is needed. This type of softener is said to save up to 40 percent on salt and up to 50 percent on regeneration water by not regenerating until needed. Timers control regeneration of the other automatics. And at least one automatic water softener employs water *use* to determine regeneration cycles ["Twin-Turbine Softener Knows When to Regenerate," PS, Oct.].

Location is all-important, since it determines what water—all or little

Heating precipitates some kinds of hard-water scale, making your water heater first to succumb. This electric heater's efficiency was impaired long before it failed.

Pipe scale so extensive that water can scarcely pass through is one result of hard water that you can prevent by installing a water softener.

—is softened. For example, water to outdoor taps should not be softened, nor should that for toilets—unless you can't avoid it without a partial replumbing of the house. If toilet-bowl scaling or staining is a problem, however, softening may eliminate it (ask your dealer). Some households soften hot water

Relative hardness of water

Relative hardness	Grains per gallon	Parts per million
Soft	Fewer than 1	Fewer than 17.1
Slightly hard	1 to 3.5	17.1 to 60
Moderately hard	3.5 to 7.0	60 to 120
Hard	7.0 to 10.5	120 to 180
Very hard	More than 10.5	More than 180

only; but to get full benefit, you must soften both hot and cold.

Trace your house water pipes from the meter (or pump) toward the water heater. You can install the softener at any point between the last branch of pipe to an outdoor tap and the water heater.

Continued

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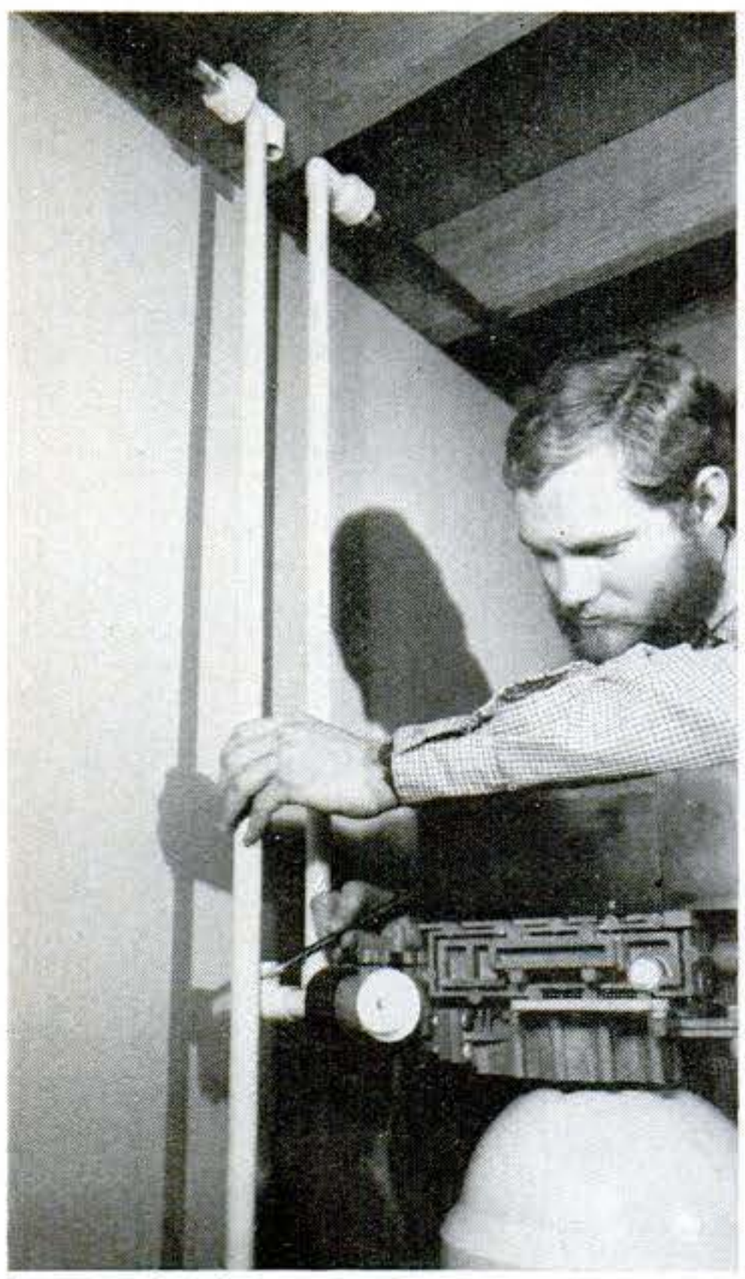
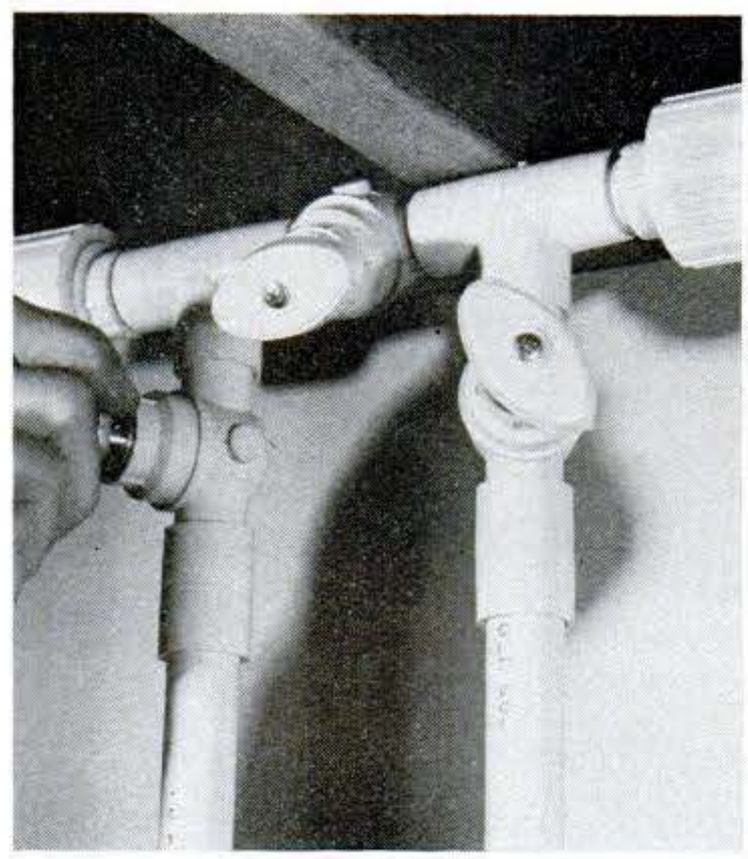
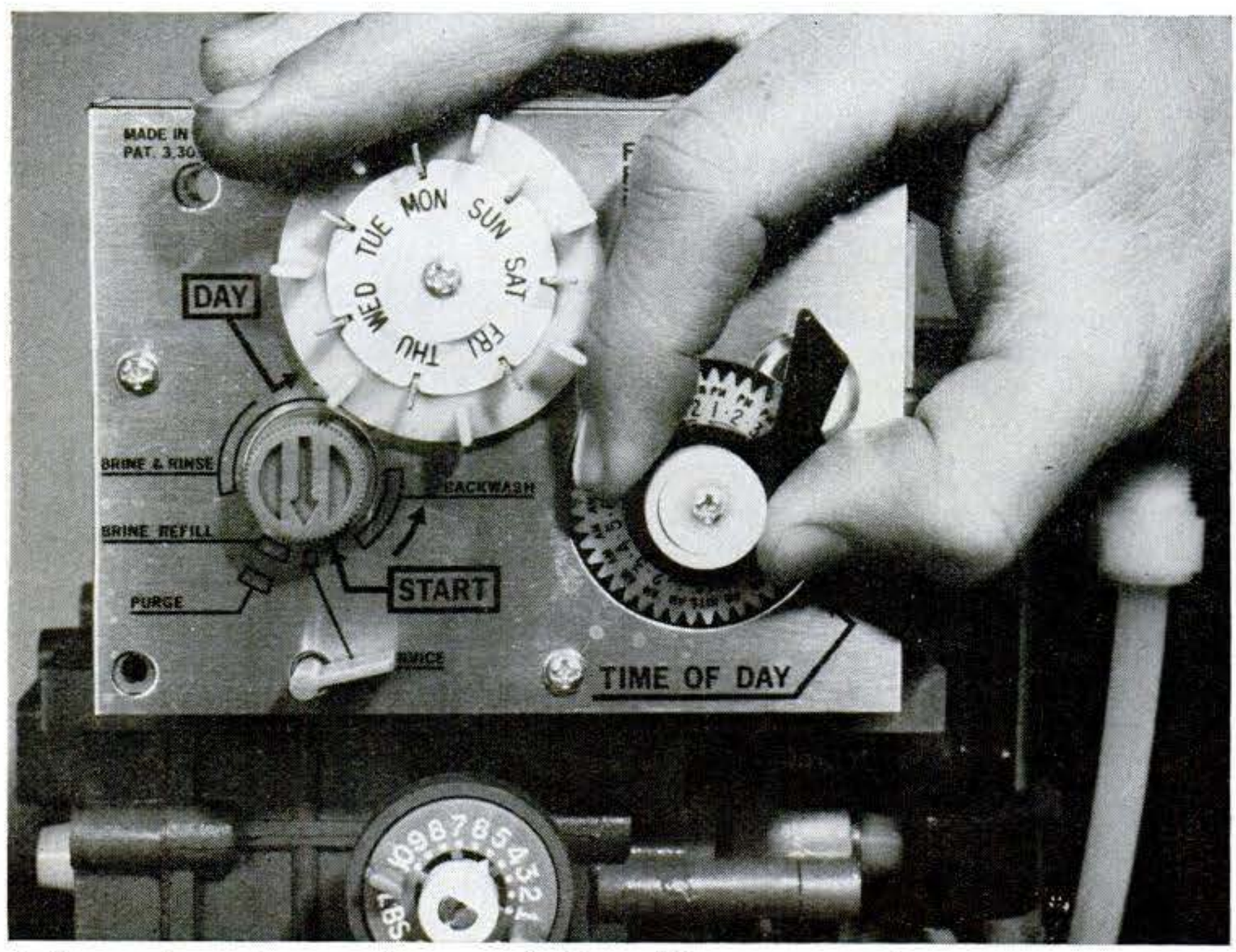


Cut out a section of cold-water main before it reaches your water heater (top photo; also see drawing). Install adapters and elbows; solvent-welding vinyl pipe and fittings beats cutting, soldering, and threading metal pipe or tubing. Fit up service pipes with the softener in place (bottom).

Provide means of easy disconnect at the softener. This one adapts to CPVC with rubber-gasketed unions. Hand-tightening of flange makes hookup watertight.



Make your own bypass-valve setup from stop valves and T's in place of elbows. In normal operation, lower valves are open, center valve closed.



Adjust softener's controls per maker's instructions. Some automatics, such as this one, use a timer to regulate regenerations; others use water sensors.

In locating your softener, keep in mind that you will have to carry sacks of softener salt to feed it, and you may need an electrical outlet nearby for the timer or sensor. Also remember that waste water must be piped to a drain—preferably a floor drain. Softener wastes should not harm sewers and septic systems; you should be able to dump them into a laundry tub, washer standpipe, or special sink trap for dishwasher drainage. A garden hose may be used, but ⅜-inch clear vinyl hose is less conspicuous.

Cut out a piece of the cold-water main, and pipe one cut end of it to the softener's inlet, the other to its outlet. Water will thus flow through the softener and back into the house main. (Threaded pipe will have to be rethreaded, or non-threading adapters must be installed.) A copper or plastic main can be fitted with adapters for indoor potable-water use to whatever type of pipe you want to use for the softener hookup, provided it's okayed by local code.

Easiest pipes to use are flexible ones, such as PB (polybutylene) or PE (polyethylene). Sometimes flexible connectors can be purchased specifically for hooking up a softener. For a rigid installation use PVC (polyvinyl chloride), CPVC (chlorinated polyvinyl chloride), copper, brass, or galvanized steel, plus matching fittings. The photos show an installation in easy-to-handle solvent-welded CPVC.

Even rubber-hose connectors may be used, if they're NSF-approved for carrying potable water. (Ordinary garden hose is not.) Pipe size for the hookup should equal that of the house main.

Most water softeners have a built-in water-bypass system to supply hard water while the unit is regenerating. For about $12 more you can get an add-on bypass valve that will adapt to your piping setup to give normal hard water when the softener is removed for servicing. In any case, provide unions or other easy-off connections on both inlet and outlet pipes to let you remove the softener without cutting pipes.

Make sure your water-supply system can provide the minimum water flow that softeners need to recharge themselves effectively. Something like three-gallons-a-minute flow at 20 psi does the job for most—ordinarily no problem. During regeneration, a pound of softener salt will rejuvenate about 2000 grains of hardness (to soften 200 gallons of water at a 10-gpg hardness). PS

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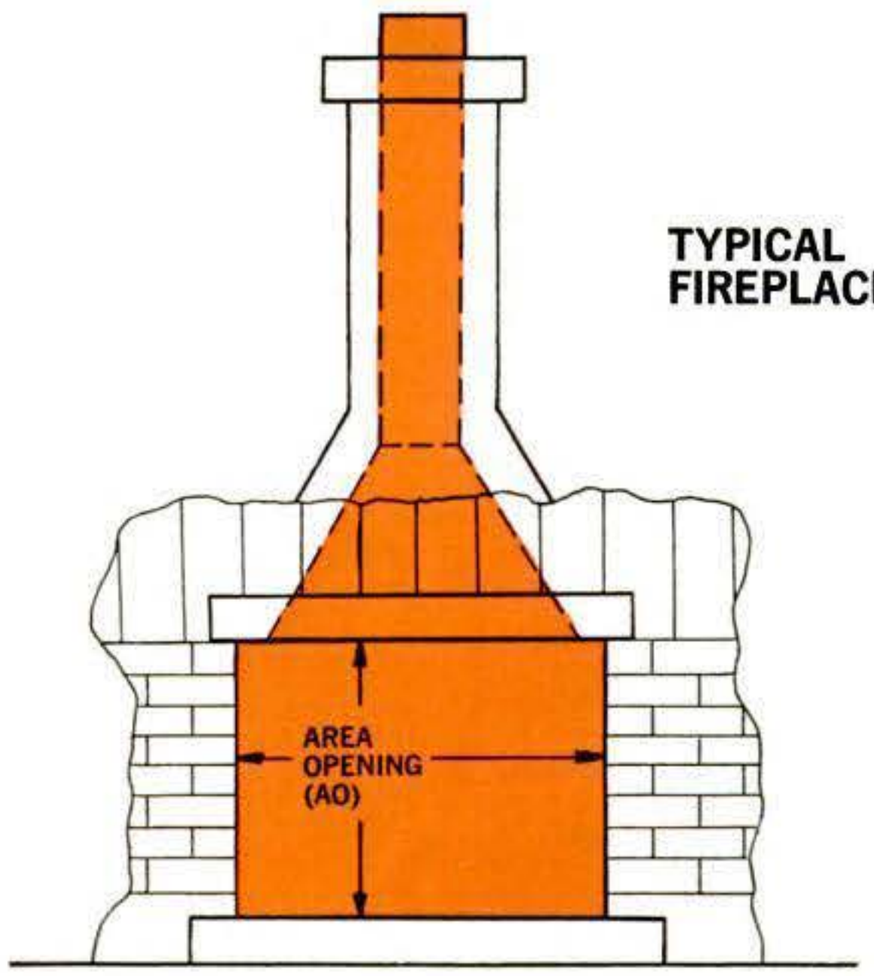
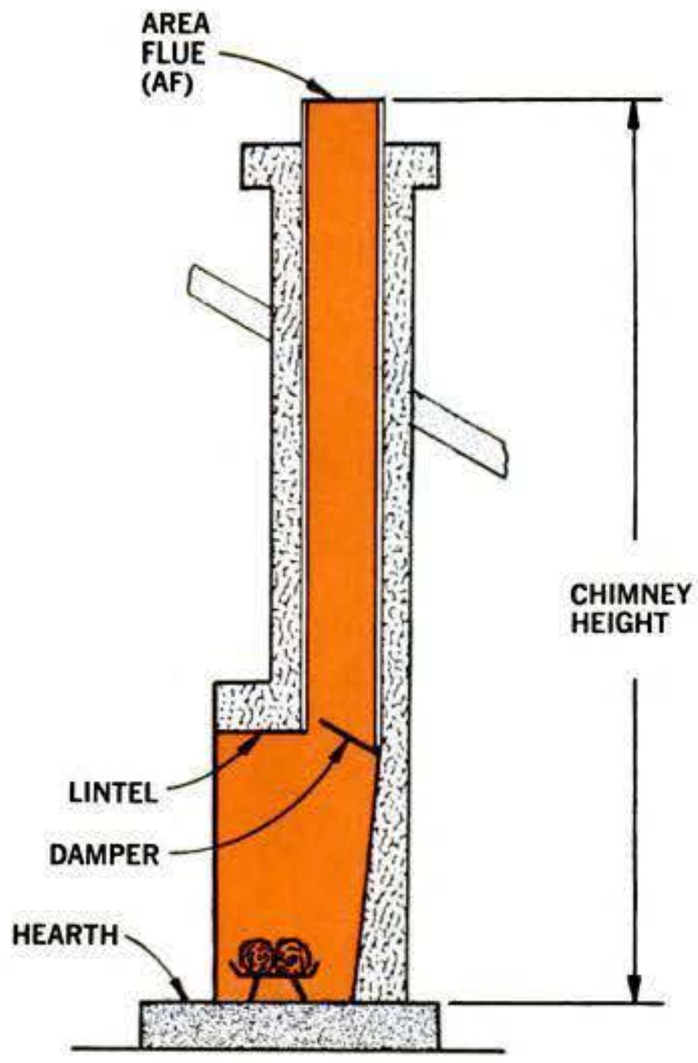
Measure your fireplace for top performance

By GEORGE A. REPAS





Most fireplace malfunctions can be attributed to lack of draft. By determining the draft in your fireplace, using my formula and graph, and by making some simple fixes, you should be able to cure even the most stubborn smoky fireplace.

The first step is to measure the height of the chimney. Drop a weighted string down the chimney and measure its length. Next, measure the inside dimensions of your flue and compute its area (AF). Finally, measure your fireplace opening, compute its area (AO), and divide AO by AF. Now plot your findings on the graph at left.

If your fireplace plots well below the diagonal line, you have big problems. If it's on the line or near it, you should get smokeless operation during cold, clear weather, but you may experience an occasional problem on warm, windy days. If your fireplace plots well above the line, smoke should never get in your eyes.

- *Below the line:* Your fireplace has little natural draft, and severe modifications may be necessary for smoke-free operation. One solution: Install a glass fire screen that com-

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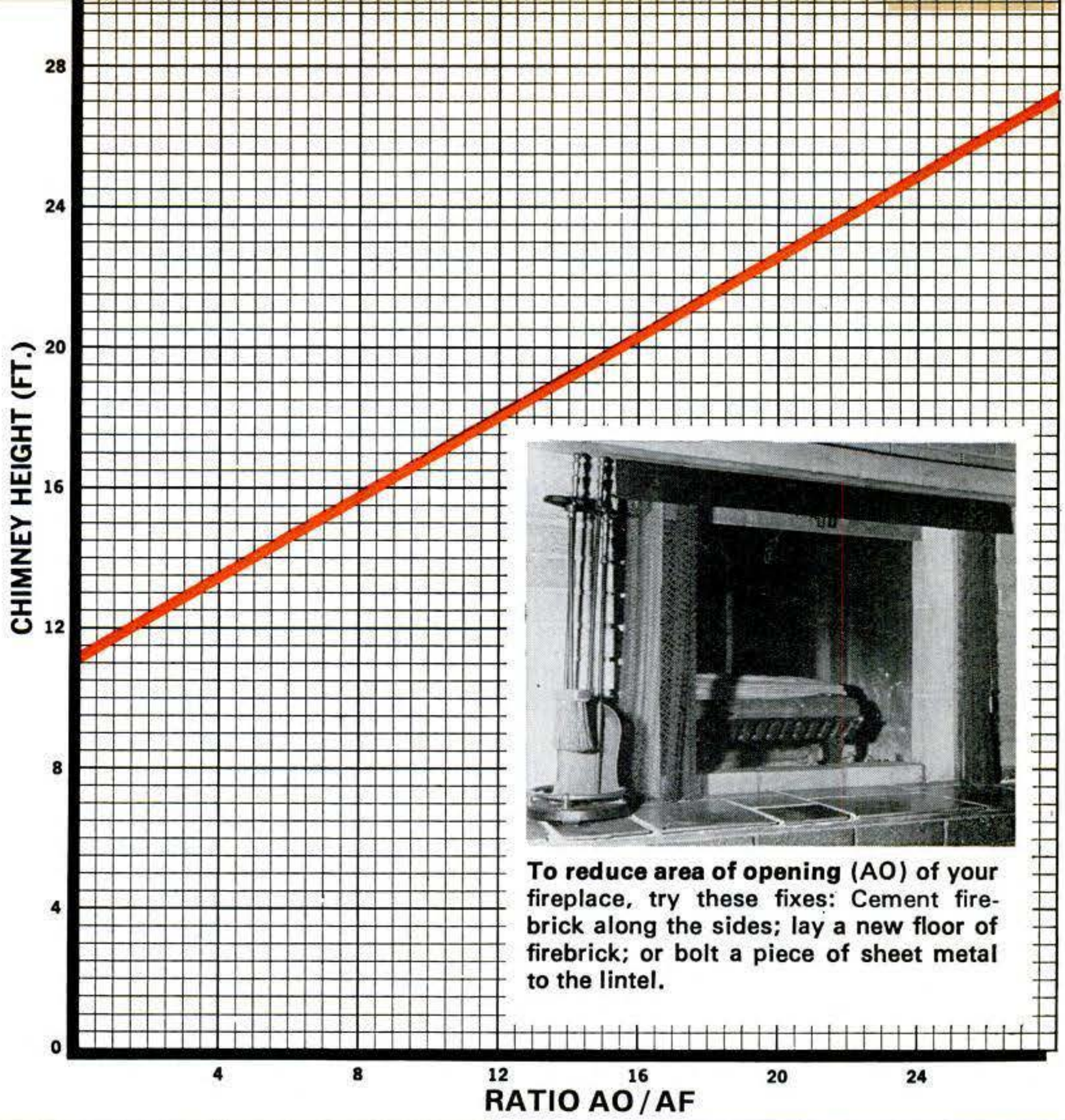
letely blocks the fireplace opening. n this case, the small holes at the ottom of the enclosure and the eakage around the frame become he new AO, and the fireplace will lot above the line.

• *Near the line:* You may want o improve the draft (by reducing he AO) with one or more of the nethods noted with the photograph for details on the raised-hearth or owered-lintel fixes, see "You Can ncrease Fireplace Efficiency," PS, Nov. '75].

Changing flue size would also elp, but this is rarely practical. Raising the height of your chimney nay be easier, depending on its onstruction. If it's sheet metal, nerely adding a new section may e enough. If your chimney is brick r stone, it will take trowel work.

Even if your fireplace plots above he line, malfunctions may occur. Then you must look to other areas here the natural draft of your himney may be disturbed.

Tall trees near the chimney may e inducing severe downdrafts in indy weather; some trimming may e in order. Chimneys should be at east two feet above the highest oof line (ridge), or three feet bove a flat roof. PS



To reduce area of opening (AO) of your fireplace, try these fixes: Cement firebrick along the sides; lay a new floor of firebrick; or bolt a piece of sheet metal to the lintel.

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Damadian's supermagnet

[Continued from page 79]

Finally the magnet could produce a constant 1000-gauss field that was uniform enough to give an NMR signal.

But there was a problem with the RF coil. At first, Damadian tried a shortcut. He built a giant version of a one-inch NMR coil—but it wouldn't give an NMR signal. Hundreds of computer—and construction—hours later, he and Goldsmith produced a smaller coil that worked.

For the final test, Larry Minkoff seated himself on a small wooden platform and raised his arms. Damadian tugged the revised coil down over Minkoff's chest, then flipped a switch. The motorized platform slid back until Minkoff was within the magnet's field. The seat slowly creaked back and forth inside the bore as the FONAR spot scanned a section of Minkoff's chest.

On the black video screen, square bits of color marched in rows across the screen, forming a pattern (see photo).

Damadian was jubilant—the scan showed more detail than they had hoped for. A strong signal, coming from the area of the blood-filled aorta, showed up a bright orange, and the air-filled lungs, with a very weak signal, appeared as dark blue bodies. The shape of the lungs was clearly recognizable—in fact, the left lung (which the heart crowds a bit) was slightly irregular in shape and smaller than the right lung. Damadian pointed to the lungs. "If there were a tumor in here, it would be duck soup," he said. "It would show up clearly as an abnormally bright mass on the image."

The work ahead

The next step for Damadian and his associates is to refine the sensitivity of their equipment—and then try it on a patient with a known tumor. Even if the tumor is detected, there are still years of work ahead. The healthy body will have to be mapped by NMR, so abnormal signals will be recognized when they show up on the scan. The chemical fingerprints of all cancerous tumors must be found, then analyzed, then matched with medical records. And, the thorniest problem of all: Damadian will have to prove that his equipment discriminates accurately between cancerous tissue and other sick, but noncancerous, tissues.

If he can do all this, Damadian may indeed lead us into a "new age of electronic medicine." PS

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SHOP TALK

By AL LEES

Now there's a shouting star

That star I hung toward the top of last year's Christmas tree (above) was more than ornamental. It was an alarm that would shout "Fire!" if the tree started to burn while I was asleep upstairs. I took the manufacturer's word for this, but later, as I was packing up the tree at season's end, I became curious. I tried to waken the silent alarm by holding a match near those slits in the star. No response. So, before wrapping the star for re-use this year, I dangled it from the end of the fireplace poker over a flaming post-Yule log. That made it yelp—and an effective alarm it is.

You can order a star for your tree by mailing $10 (plus 75¢ postage and handling) to Ideas International, 4701 E. Kessler View, Indianapolis, Ind. 46220. The alarm operates on a penlight battery, so it stays on guard even when your tree is unplugged.

Which brings us to some general advice about Christmas-tree safety: Those lights can invite trouble. For 100 bulbs you'll have over 400 electrical connections—maybe as many as 2000 on a tree with twinkle lights. That's a heavy potential for shorting.

So it's essential to keep cut trees in a water-filled base. Trim the trunk at an angle to expose a maximum number of wood cells, and keep the water level above the cut all season. Don't buy a dried-out tree (tap the base sharply on the ground: if the tree showers needles, it was cut too long ago); discard your tree as soon as needles drop when you pull a branch between your fingers.

And don't feel falsely secure because you use an artificial tree. Some are flammable, and even those that aren't probably have a metal framework that can short-circuit a string of lights with worn insulation. So never leave any tree plugged in while you're away or asleep. Don't turn the season's warmest symbol into a hot statistic.

Second-guessing the judge

The flood of mail praising the plywood-contest projects we presented in August carried along a few inevitable pebbles of protest—including a half-dozen readers who accused the judge (me) of making an impractical selection for top prize in the Indoor category. It's a lot easier to second-guess on the basis of 12 top designs than it is to dredge that dozen up out of a sea of 1000 entries, of course. Still, I'll acknowledge the consistent complaint about the sawbuck table: that it doesn't provide for conventional seating.

This handsome project wasn't submitted as a dining table, but APA chose to accessorize it that way for the photo, and they assure me that with the chairs shown there's no problem about tucking your knees in far enough. As for your feet—you prop them in the 6" slots, which are ample unless you insist on wearing snowshoes to dinner.

Meanwhile, we've launched our '78 contest (new rules were announced last month and will be repeated in our Jan. and Feb. issues). Deadline for entries is a month earlier this year—March 1—as you may have noted from those posters APA has peppered lumberyards and home centers with, coast-to-coast. They read: "Wanted: Plywood Prize Winners—$3000 in Rewards."

Those of you who requested more detailed plans for these projects will be glad to hear you can get a giant plans sheet giving cutting and assembly instructions for all 12. Send $1 to American Plywood Assn., Box 2277, Tacoma, Wash. 98401 and ask for Contest Projects.

Put a good face on it

Looking for worthwhile winter workshop projects, but wary of fussy finishing? Plastic laminate's your answer—and one of the leading laminate makers has prepared a plans brochure titled "Four Easy Projects." A cube table (shown), bookcase, and planter shelves can be faced with any of Wilsonart's 108 patterns—marble, slates, woodgrains, solid colors, and designs. The fourth project concerns facing utility areas: pantry or laundry shelves, window seats or sills.

Wilsonart offers the handsomest

marble patterns on the market, and the cube table is an ideal use of them. For the brochure, see your Wilsonart dealer or get his address from Ralph Wilson Plastics Co., 600 General Bruce Drive, Temple, Tex. 76501.

For the record

At-job DIY instructions have now gone audio. Peerless Faucet Co. is packing a 33⅓-rpm record with every faucet to supplement the illustrated instructions (see photo below). Peerless makes a full line of kitchen, lavatory, tub, and shower faucets designed for DIY installation. You just take a portable turntable to the job and do what the man says, while looking at the pictures. You don't even have to be a patient listener, since the recorded instructions average only about five minutes in length. PS

Copyrighted material

THE PLATTER IS THE MOTOR.

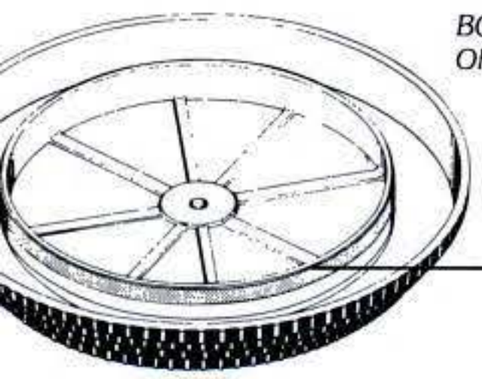
Fisher introduces a major advance in audio technology: the linear motor 120 pole, direct drive turntable.

One of the problems in improving ect drive turntable performance is lucing wow & flutter due to cogging ion of the motor.

With its limited number of poles ually 12) and its relatively slow erating speed, most conventional ect drive systems also have an in- rent problem of low starting torque. To solve these problems, Fisher has gineered the linear motor, direct ve system. The new Fisher MT6225. n effect, the platter becomes the ntable's motor. And Fisher's 120 e design practically eliminates gging action, and lowers wow & ter to a totally inaudible 0.03%. The linear motor direct drive system ther reduces turntable rumble to an remely low −70 dB, far below aring level.

HOW IT WORKS

A continuous band of ferrite ma- al, containing 120 magnetic poles, ttached to the inside bottom rim of platter. To start platter rotation, h pole opposes e of the electro- gnetic drivers the base top. ch of the 120 poles is attracted or elled as it passes the driving electro- gnets for smooth, stable operation.



An electronic sensing device moni- s the platter's speed, and acts as a vo-feedback control to maintain practically perfect speed accuracy. Built-in strobe and pitch controls are provided.

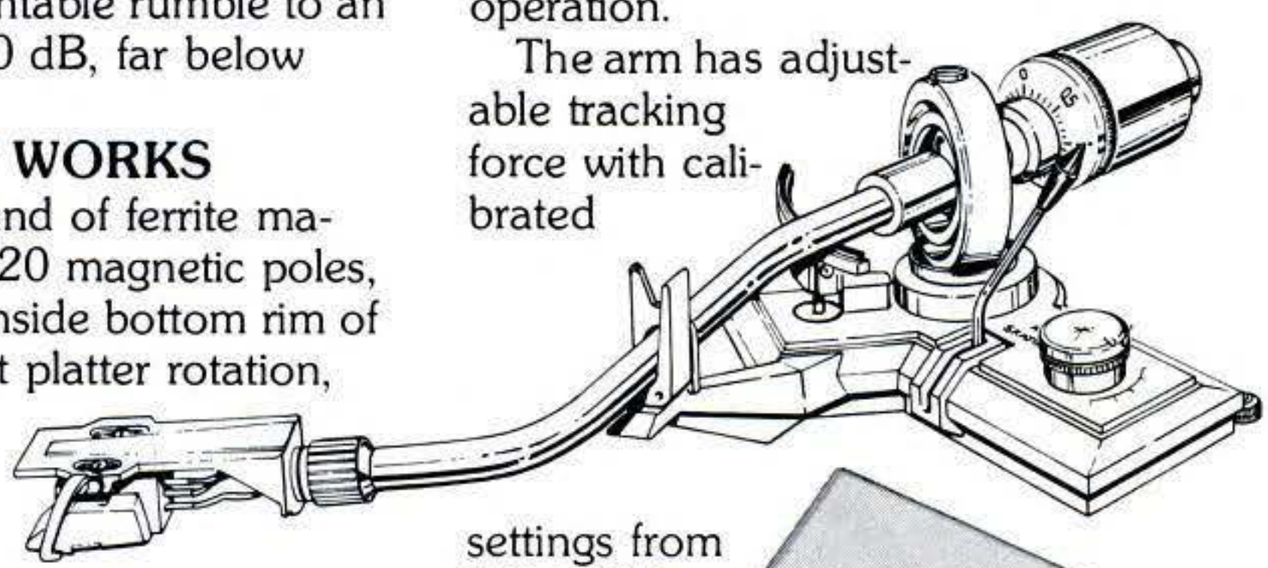
The speed accuracy of the system is independent of line voltage fluctuations.

THE ARM

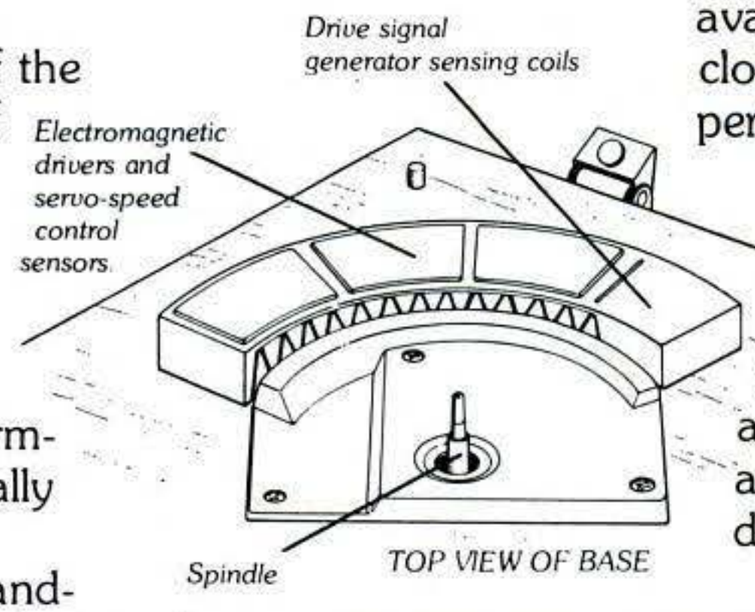
The Fisher MT6225 is equipped with a professional-type gimbaled tone arm for performance to equal its technically advanced motor design.

The arm accepts all standard cartridges. The auto-return system, which returns the arm to rest at end of a record, is designed with no restraints on its lateral or vertical motion during operation.

The arm has adjustable tracking force with calibrated settings from 0.6 to 3.5 grams. There's also precise variable anti-skate, and viscous damped cueing. The MT6225 also has a heavy cast-aluminum platter, and a massive integrated base to absorb vibration.



In all, there is no other turntable available that comes closer to the perfect performance . . . or the ultimate in reliability. Fisher MT6225, for about $250.† See it now at fine audio stores and the audio section of department stores.



Motor	Linear Direct Drive
Wow & Flutter	0.03% WRMS
Tracking Force Range	0.6 – 3.5 grams
Rumble	−70 dB (DIN B)
Maximum Tracking Error	± 1.5°
Auto Stop	Yes
Auto Reject	Yes
Cueing	Viscous Damped
Anti-Skate Control	Adjustable
Platter Weight	2.2 lbs.
Speed Selector	33/45 rpm

FISHER

The first name in high fidelity

Fisher Corporation,
21314 Lassen St.,
Chatsworth, Calif. 91311

MT6225

77, Fisher Corporation

†Manufacturer's suggested retail price. Actual selling price determined by individual dealer.

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Exxon's new motor oil 200,000,000 gallons

Imagine these rows of one-gallon gasoline cans continuing for over 5,000 miles and you'll have an idea of what Exxon's new

New gasoline-saving UNIFLO

It can help you save money and help America conserve energy.

Exxon has developed a new motor oil that could save over 200,000,000 gallons of gasoline a year if only one out of every 20 cars used it instead of typical multi-grade oils.

And we think many drivers will want to change to our new Uniflo motor oil, because it saves money.

Test cars *averaged* 16 extra miles from each tank of gasoline after a conditioning period with this new motor oil.

How Exxon's new gasoline-saving Uniflo motor oil works.

Exxon Research has found a way to make this golden, natural oil lighten the load on a car's engine.

Unique, oil-soluble friction modifiers cut the resistance between moving parts, and let the engine put more horsepower into moving the car.

In an average car, the friction-reducing action of Uniflo builds up gradually for about 1,500 miles as the

New from Exxon Research.

Free folder *tells how this new super-premium multi-grade oil saves gasoline. At your Exxon station. Or write New Uniflo, P.O. Box 2180, Houston Texas 77001.*

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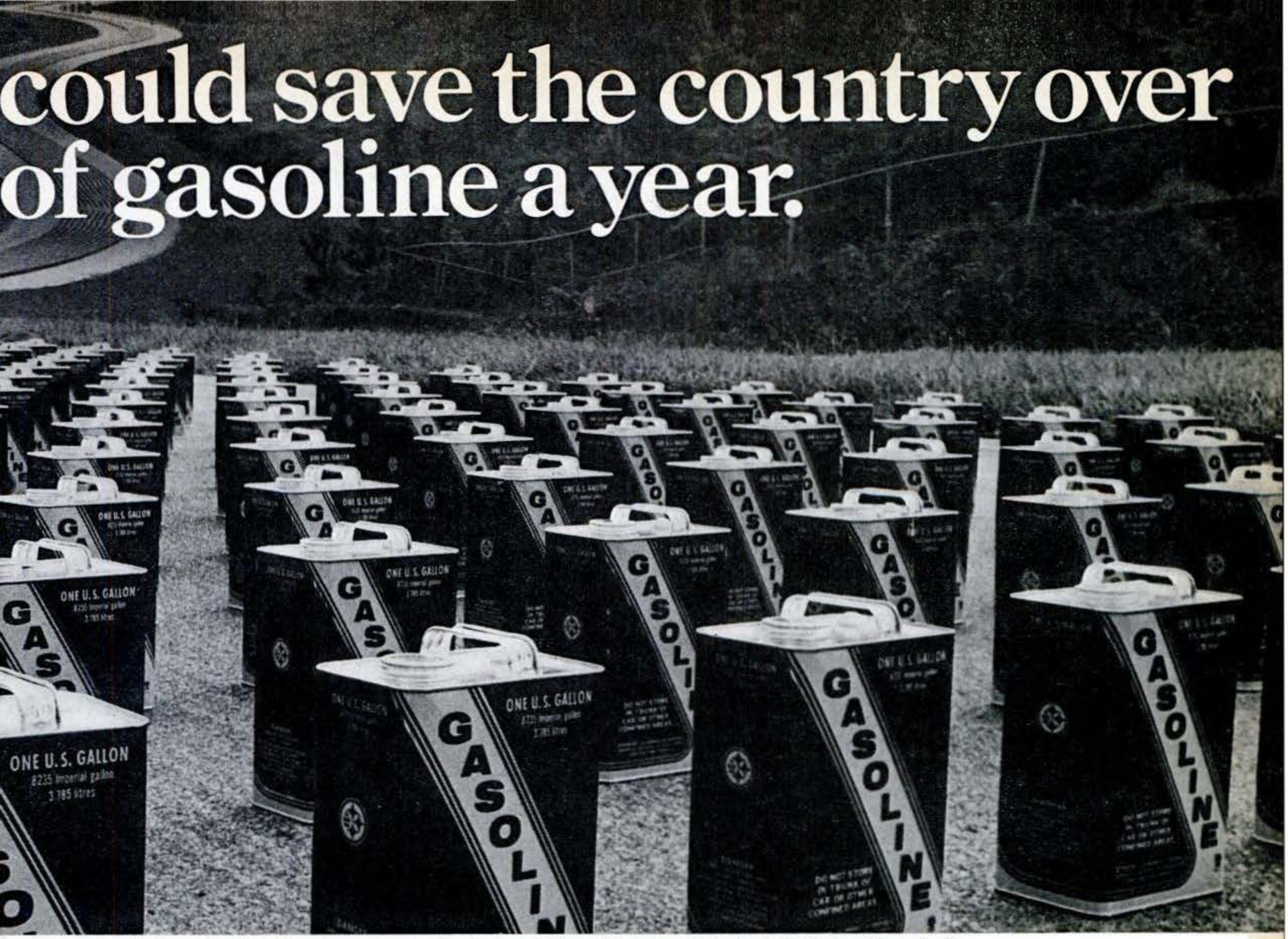
could save the country over of gasoline a year.



gasoline-saving Uniflo motor oil could conserve each year if only one out of every 20 cars used it instead of typical multi-grade oils.

motor oil.

new motor oil conditions the engine.

From then on, with new Uniflo there is measurably less drag in the engine than with a typical multi-grade oil.

So the engine turns easier and needs less gasoline. And when you save gasoline, you save money—while helping the country conserve.

Savings proved in 417,000 miles of driving.

We compared new Uniflo and typical high-quality multi-grade oils in driving tests using a fleet of cars that logged over 417,000 miles—114,000 on new Uniflo.

There were 19 cars in this fleet, ranging in size from a VW to a Cadillac. Here's what we found:

Compared with a typical, high-quality multi-grade oil, new Uniflo demonstrated measurable gasoline savings in 18 of the 19 cars—savings as great as 26 extra miles per tankful in one of the test cars.

Savings averaged 16 extra miles per tank of gasoline.

The whole fleet of cars *averaged* 16 extra miles per tankful of gasoline, after conditioning with new Uniflo.

That's the same as saving the equivalent of about 3¢ a gallon on all the gasoline they used.

We hope you'll try our new gasoline-saving Uniflo motor oil soon. It's Exxon's best engine protection ever, with new, friction-reducing capability.

It is also an economical way to conserve energy.

EXXON

"Thanks for coming by."

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UPGRADE THERMAL EFFICIENCY

First in a series of energy-saving home improvements

Heat-wasting doors

You can plug the leaks

By THOMAS H. JONES

Next to windows, doors are the worst sources of heat loss in an otherwise well-insulated house. While losses can be reduced by adding storm doors to front and back doors—or replacing them with insulated steel doors—two doors remain that are difficult to treat: sliding glass patio doors and the attic door.

Sliding glass doors have other problems besides heat loss—they are hazardous; they are difficult to lock and thus are security risks; and when they are located just three feet from a kitchen door, as ours was, they are superfluous. For all of these reasons we replaced the sliding doors in our dining room with a casement window, and added a cupboard on either side, a cornice above the window, and a window seat below it. The heat loss was cut from 3900 Btuh to 870 Btuh.

Attic door

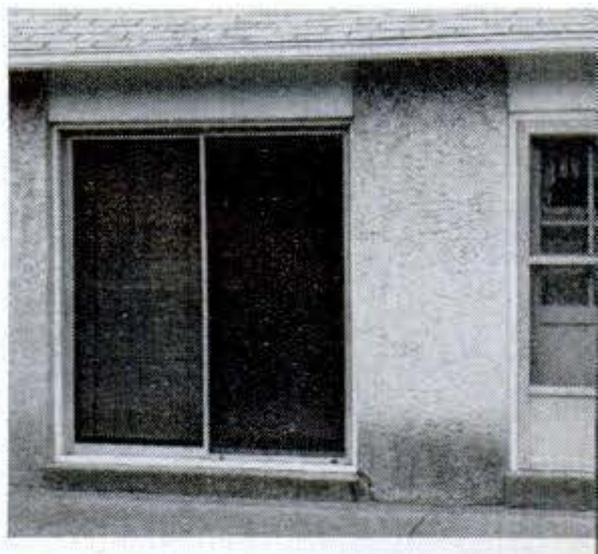
Our attic door, as in many houses, was simply a hollow-core flush door. But if the attic is unheated, this is an exterior door. Weather-stripping and plugging the usual inch-wide gap at the bottom of the door help, but the heat loss is still high—1200 Btuh in our case.

When we went over the house a few years ago to determine the best places to insulate ["How to Figure the Best Places to Cut Heat Loss in Your House," PS, Sept. '75; also reprinted in *Solar Energy Handbook,* 1978], we used a combination of weather stripping, 5/8-inch poly-

Continued

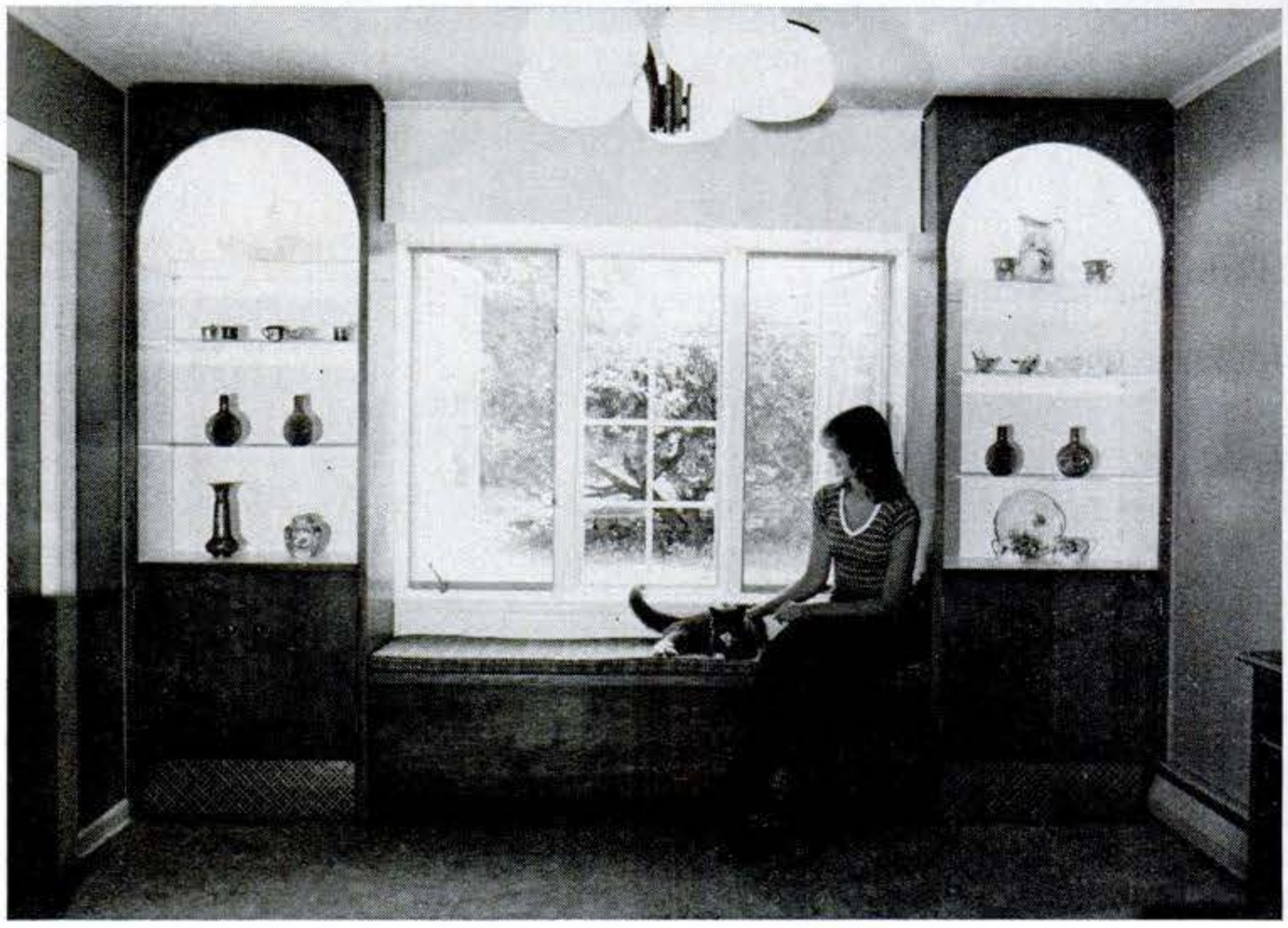
The drastic approach:

Replace unused door with thermal window



BEFORE

AFTER



Sliding glass doors (top photo) were superfluous and a security risk. Double-glazed casement window, flanked by floor-to-ceiling cabinets (above), is now focal point of dining room.

Bottom of opening was framed in to support three-section casement window. Vinyl siding was added later to cover framing.

Copyrighted material

"How a circular saw changed my life."

Believe it or not, it's the sort of thing we hear all the time.

Somebody has a job to do that's just too tough to do by hand. Or too time consuming. Or too impossible.

Like paneling to rip. Window cutouts to make. Shelves to trim. Studs to cut.

So he turns to one of our circular saws for help. To our Model 4511, for instance.

A lot of tool for $32.99.*

7¼ in., 1¼ hp, 5,800 rpm, rugged. With ball-bearing construction for longer, smoother running. A big, wraparound base for extra support. Calibrated scales for fast, accurate depth-and-angle adjustments. Telescoping bladeguard and double insulation for maximum protection.

Of course, depending on the job, he could also pick one of our jig saws. Or sanders. Or routers. Or planes. Or drills. But the outcome would still be the same.

The enjoyment of a job well done. The satisfaction. The sense of accomplishment.

Graduating from the basics to bigger things. From a gatepost to a game room. Or even a gazebo.

And a whole new way of living.

Which leaves us with a big responsibility. The tools we make have to be equal to the job. They have to feel right in a man's hand. And they have to hold up.

That's how it ought to be with everybody's power tools. That's how it is with ours.

The reason is just plain good engineering. The kind that only comes with half a century of industrial experience and on-the-job performance. It goes into every Rockwell portable and stationary tool we make.

It's why they're all made tough, accurate, powerful.

When a man puts his life into something, it's the least we can do. You can depend on it.

Rockwell.

It's the same name industry's been depending on for 50 years.

Rockwell International

*Manufacturer's suggested retail price.

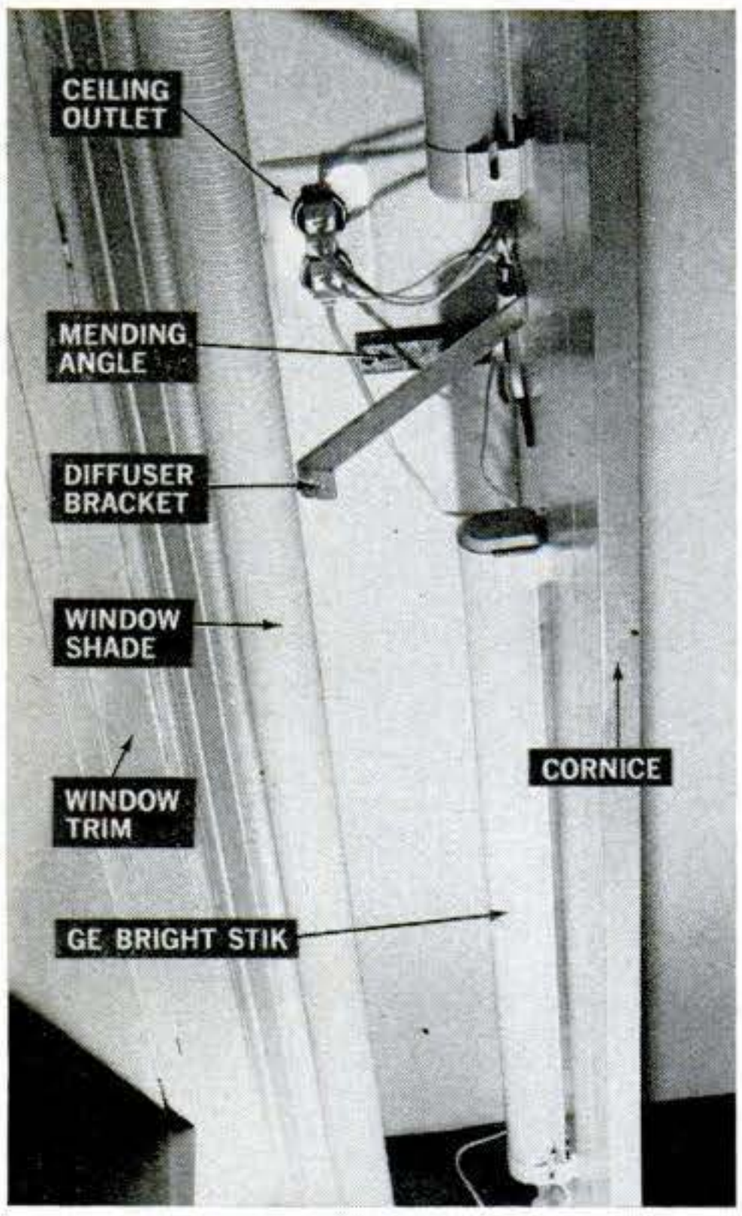
[*Continued*]

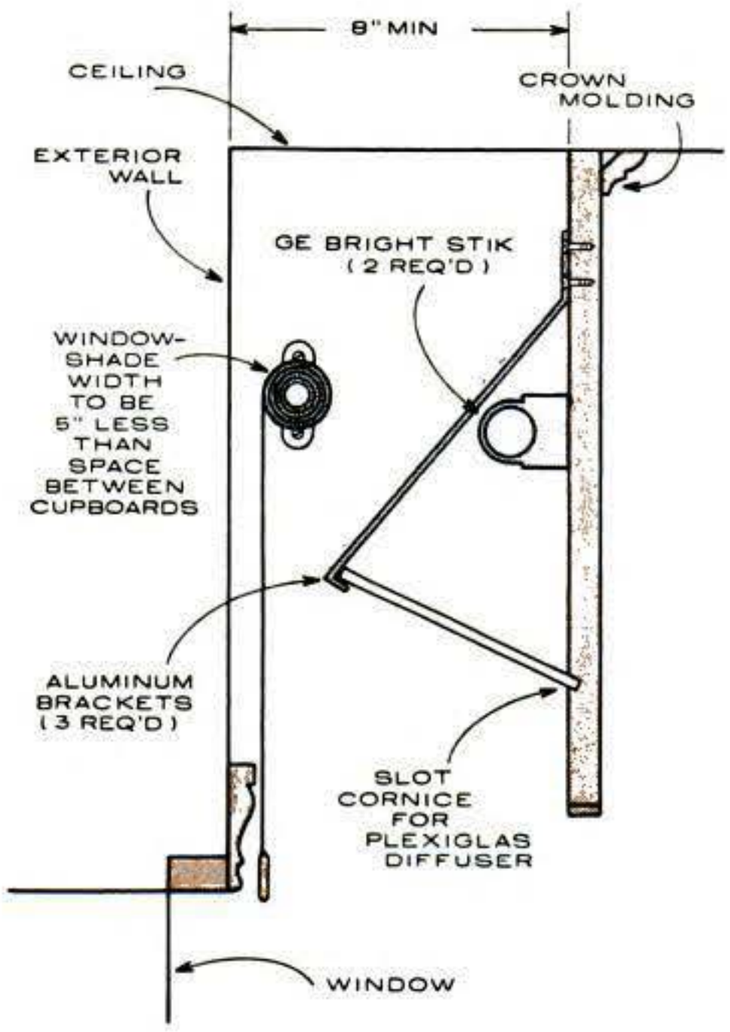
foam board tacked on the back, and several layers of polyfoam stacked at the bottom of the door. This seal has cut heat loss in half.

When summer came, we installed an exhaust fan to cool the attic during the day and to draw cooler air through the house via windows and the attic door in the evening, when it became cooler outside than inside. This meant leaving the door open—which opened a whole new playground for our cats, and also opened our house to insects that could get through the ½-inch cloth mesh behind the exhaust-fan louvers. For summer months we obviously needed a screened opening in the door. We also felt we could cut the winter heat loss substantially more.

To accomplish this, we framed out the back of the door with 1-by-3's and packed in R-11 insulation, double-weather-stripped the door with phosphor bronze, and established an extremely good seal at the bottom of the door—two-inch polyurethane upholstery foam. For summer ventilation, there's a screened opening with its own removable tight-fitting block of insulation (see photos and drawings on the following pages). PS

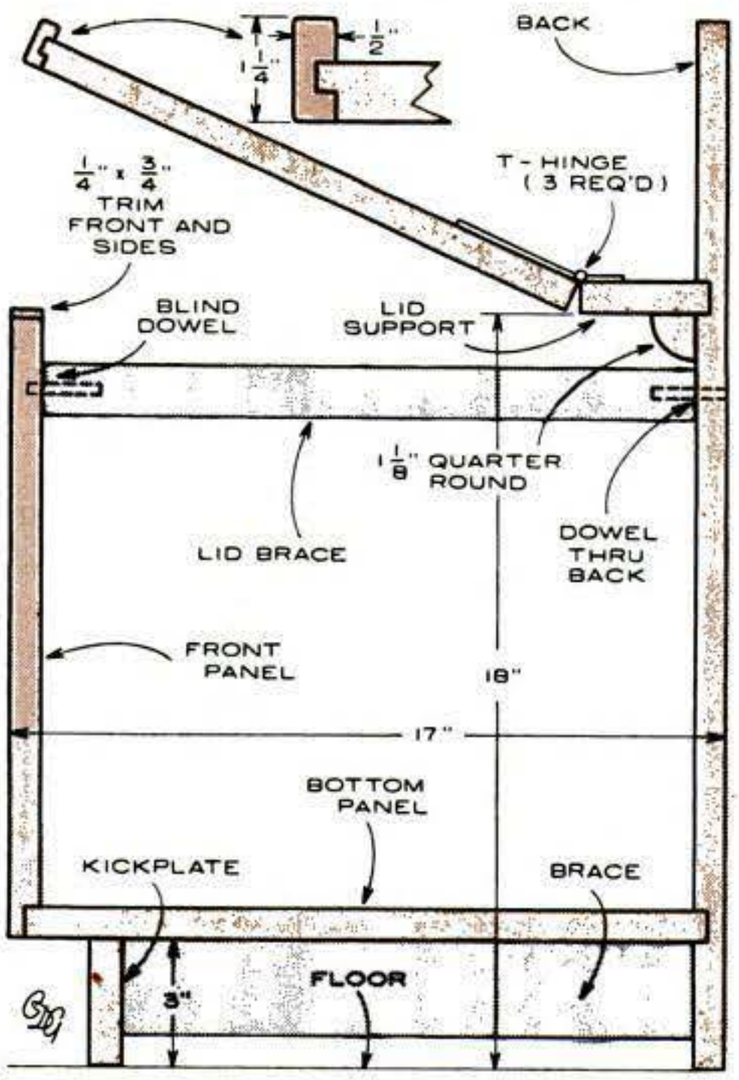
R-11 fiberglass insulation was used between studs, and under the floor of the window seat.



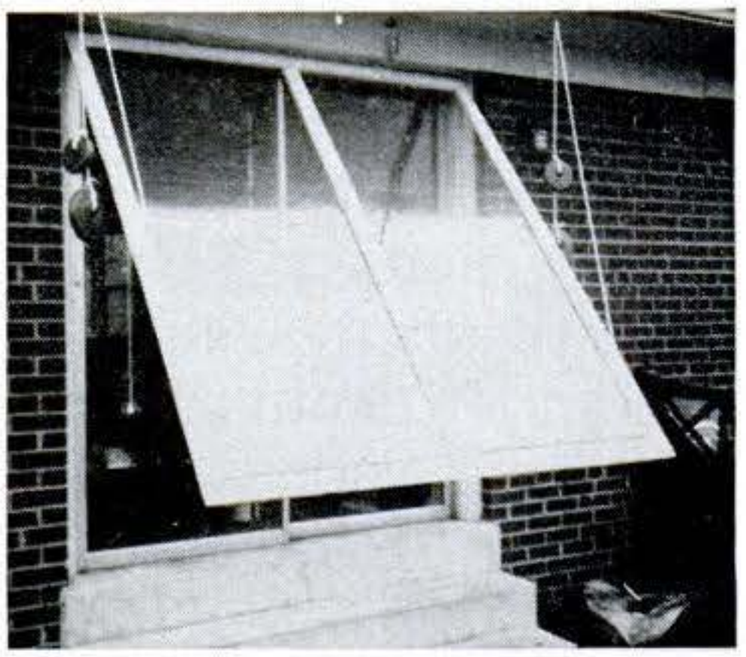


View up inside cornice (left) shows GE Bright Stik fluorescent lights, which snap in place on button pads. Drawing above shows cross section of cabinets.

Lid of window-seat box extends full length. Box provides a lot of storage, plus a comfortable seat with removable cushion in place. Drawing at right shows details of construction.



Floating storm door for patio slider



Have a single-glazed, heat-wasting patio door that you *don't* want to replace? Mine provides useful access and interior light on short winter days, but after a freezing night—and in spite of double drapes—a foot or two of ice usually formed on the glass's inner surface. Clearly, I needed a storm door.

My free-floating, top-hinged storm door can be removed in the spring merely by untying the counterweights and unscrewing the two hinges. The counterweights (two 2½-lbs. and two 5-lbs.) allow the door to swing out at bottom on mild days to permit egress for our cats and dog (see photo). A light push on the frame edge (never on the clear plastic glazing) will allow a person to go out, and the door will gently glide down to its former angle. In cold weather the door is tightly secured to the patio door frame by hooks and eyes.

The 6'-by-6'9" door is framed of 8'-by-3"-by-1" furring strips, mitered and secured by 3" corner irons. The center vertical furring strip is attached by 3" T plates. The plastic—heavy-duty drop cloth—is mounted on the house side of the frame. It's stapled to the frame every four inches. Two 1" nylon pulleys are hung from the edge of the house's overhang. The weights are rigged with clothesline and attached to the frame with screw eyes.—*James R. Burton*

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The Touch by Regency is the first fully synthesized, 16 channel scanner to put over 15,000 radio frequencies at the command of a fingertip.

It not only opens you up to a whole new world of action, it gives you plenty of features to play with as well.

For example, The Touch will never allow you to miss a severe weather warning. No matter what frequency you're tuned to. Simply set Channel 16 to the National Weather Service alert mode, if available in your area. The Touch automatically cuts into any severe weather broadcast.

In other words, it'll interrupt a raging fire to bring you news of a threatening tornado.

Here's another overriding feature. The Touch lets you set up Channel 1 as a priority receiver; and it samples that frequency every 1.2 seconds. So you won't miss any calls on your favorite channel.

Other points: there's no complicated programming to do. No crystals to buy. Simply tap out the frequency number you want, and you're there.

Or scan for action on your 16 possible stored frequencies by merely touching SC. Or search for the unknown by tapping SS. It's that easy.

And when you find new action, The Touch tells you exactly what you've found in the LED display.

The Touch by Regency. See it at your dealer's.

The Touch by Regency.
The Ultimate Scanner.

It can interrupt a thrilling fire to bring you a frightening tornado.

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UNDERSTANDING

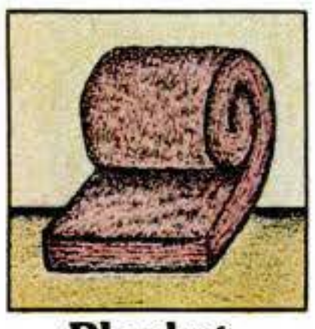
From Owens-Corning, the company that's made it for 30 years.

In 30 years, we've grown to be America's leading insulation company by preaching that pink Fiberglas* insulation can save energy—*and money*.

Now the energy crunch and soaring fuel bills have made believers out of nearly everyone. In the last four years alone, over 11,000,000 homeowners have added insulation.

If your home is still an energy-waster, tear out this ad. It'll help you save *plenty*.

Types of insulation



Blanket

Loose-Fill

Rigid

Foam

Blanket—soft, woolly, made from fibers of glass, rock or slag. Comes in slab-like "batts" or rolls. Probably in your attic right now.
Loose-Fill—sold by the bag, to be poured or "blown" into place. Made from glass, rock, slag, even macerated *paper*.
Rigid—panels of foam-plastic. Good under exterior siding or below concrete floor slabs.
Foam—chemicals that foam when pumped into wall cavities by professional contractors.

NOTE: All insulations are not alike. There's one way of being sure you get your money's worth. Insist on a brand with *this label:*

NAHB RESEARCH FOUNDATION, INC.

It means samples have been tested by *independent* experts—the NAHB (National Association of Home Builders) Research Foundation, Inc.—and found to deliver the thermal performance *claimed*.

Insulation is cheaper than oil.

**Just as in figuring automobile gasoline mileage, the amount of money you save on your home heating and cooling bills with insulation depends on a great many different factors.

Estimated Annual Fuel Savings**

	Oil Heat & Electric Cooling	Gas Heat & Electric Cooling	All Electric
Albany, N.Y.	$364	$288	$679
Chicago, Ill.	336	222	422
Kansas City, Kan.	284	173	399
Columbia, S.C.	211	144	290
Tampa, Fla.	144	132	199
Los Angeles, Cal.	156	80	286

The estimated dollar savings listed in the chart above are based on April, 1977, average energy costs in each of the cities shown, taking into account the local climate conditions.

Estimated savings are calculated for a typical three-bedroom ranch home of 1,370 square feet, going from no insulation in the attic to Owens-Corning's recommended minimum standards for that city.

These savings represent guidelines or estimates only. They do not reflect actual savings, which may vary depending on the type and condition of a home, heating and cooling system, unusual weather conditions, personal temperature preference, family life-styles, increase in energy rates and other unpredictable factors.

Important: keep all receipts for insulation you install. You may yet be allowed a tax credit for part of your expense.

What's an R-value?

Take a look at that brick wall below, and you can see why it's important to understand "R-values."

R stands for Resistance—to the flow of heat. The R-value of any material is simply a measure of how *good* an insulator the material is. The higher the R number, the better the insulator.

Pink Owens-Corning Fiberglas, for example, is a highly *efficient* insulator. A blanket just 6 inches thick has the same insulating R-value—R-19—as a wooden wall 15 inches thick or a brick wall 7 *feet* thick.

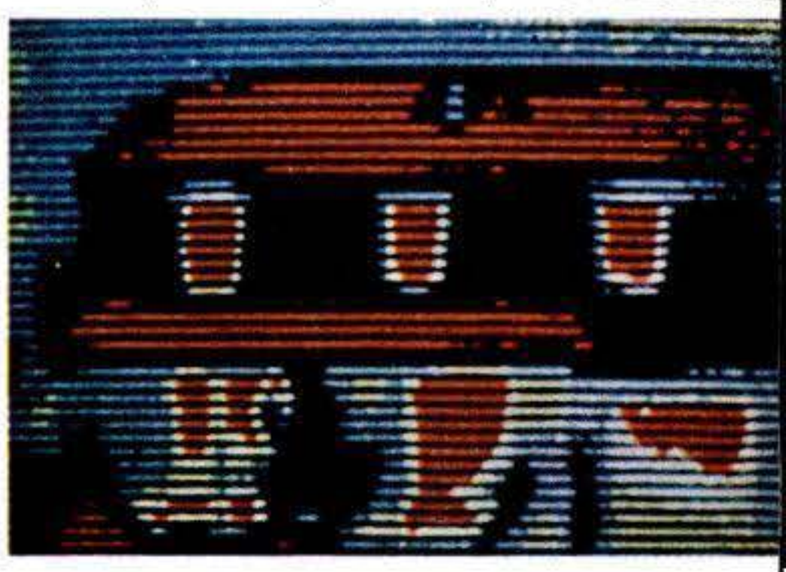
Check the Owens-Corning insulation ma on the right-hand page, and then consult your local building supply dealer or insulation contractor about the R-values—*not inches*—recommended for insulation in the ceilings, the walls, and the floors of your home.

Why you should insulate your attic first.

Below is an *infrared* photo of a typical uninsulated house. Places where heat is escaping show up red. The windows. The door.

But look at the attic.

Proof of where much of the heat is being wasted. (In the summertime, the sun's heat seeps *in* here, to run up air-conditioning



bills.) This is why the attic is one of the most important places for you to tackle *first*.

Where else you should insulate.

When you've taken care of one of the worst energy-wasters, the attic, you can turn your attention to two more areas: Exterior walls. Crawl spaces.

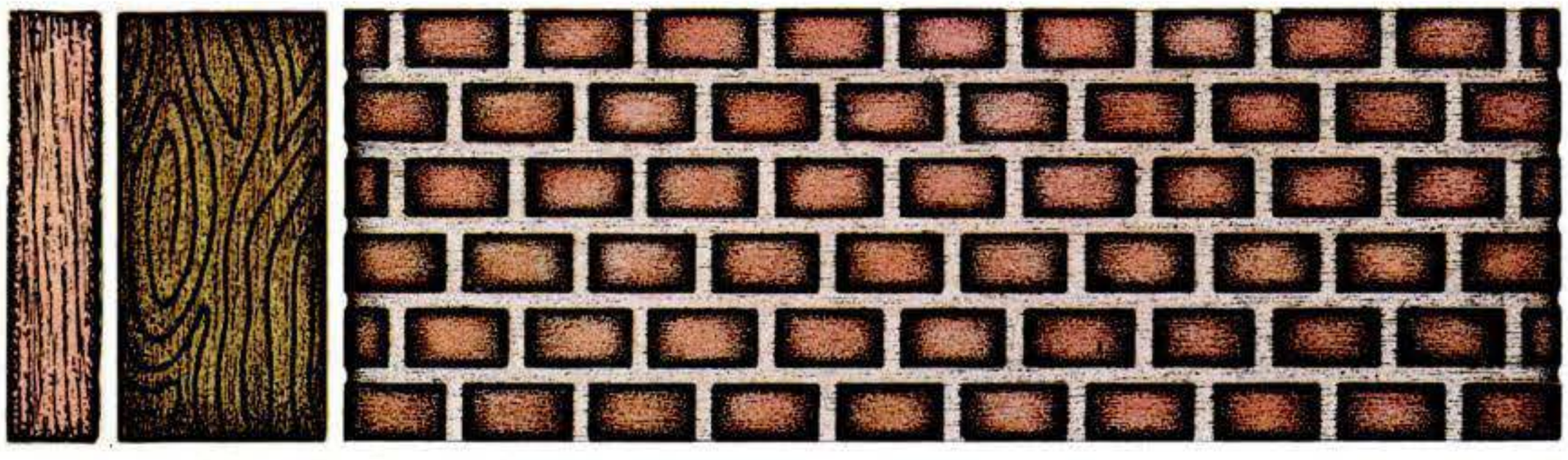
Walls may be toughest. If they're enclo on both sides, but hollow, the best thing is usually to have a professional contractor inj loose-fill insulation through small, drilled ho With unfinished walls, of course, you can ad blankets of insulation and then enclose them

Floors over unheated areas should be insulated from below. It's usually easy to ap blanket-type insulation, fastening it up into position with wire mesh, wooden cross brac or other devices.

Doing it yourself vs. having it done.

If you're handy around the house, and spare the time, you'll probably be able to ma age the biggest part of the job on your own maybe two thirds the cost of having a profe sional contractor do it.

Your *walls* could stump you, though. Fo them, a pro and his special blowing equipme might be the answer.



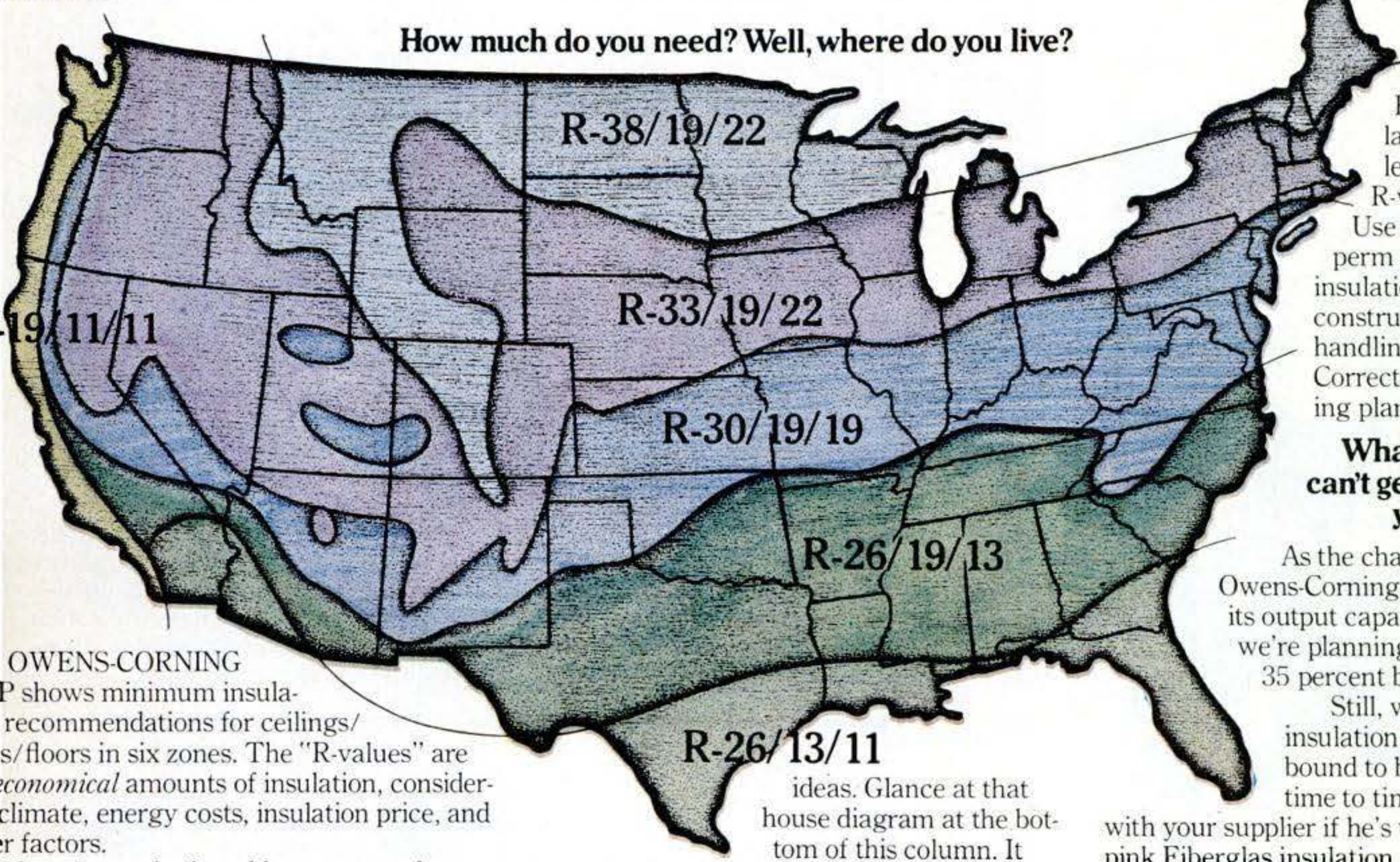
Forget inches: It's R-values that count.
6 inches of Fiberglas have the same R-value as 15 inches of wood or 7 feet of brick.

Copyrighted material

NSULATION:

(Loose-fill, *properly* installed, works well where, too. However, since prefabricated kets offer more consistent thickness and ity, many contractors prefer them for s—simply because of their more reliable ormance.)

How much do you need? Well, where do you live?



OWENS-CORNING
P shows minimum insula- recommendations for ceilings/ s/floors in six zones. The "R-values" are *economical* amounts of insulation, consider- climate, energy costs, insulation price, and er factors.

Note that attics in colder areas need as h as R-38—the equivalent of one *foot* of Fiberglas blanket insulation! About 8 es (R-26) is right for warmer air-condition- zones, and a full 6-inch (R-19) blanket even he temperate areas of the country.

How to pick a contractor.

Carefully.

Look in the Yellow Pages under "Insulation Contractors—Cold & Heat," ask your utility company for names, or consult friends.

Get several contractors to "quote" your job (by R-values, not inches), and judge by reliability as well as price. Tip: Ask the contractor for a certificate ng the insulation manufacturer's e and the installed R-value. *A sure when you're ready to sell.*

The 2 most common insulating mistakes.

cking blanket insulation tightly, y to cram more in. Wrong. It's e fluffy on purpose. Squeezing it lowers the R-value.

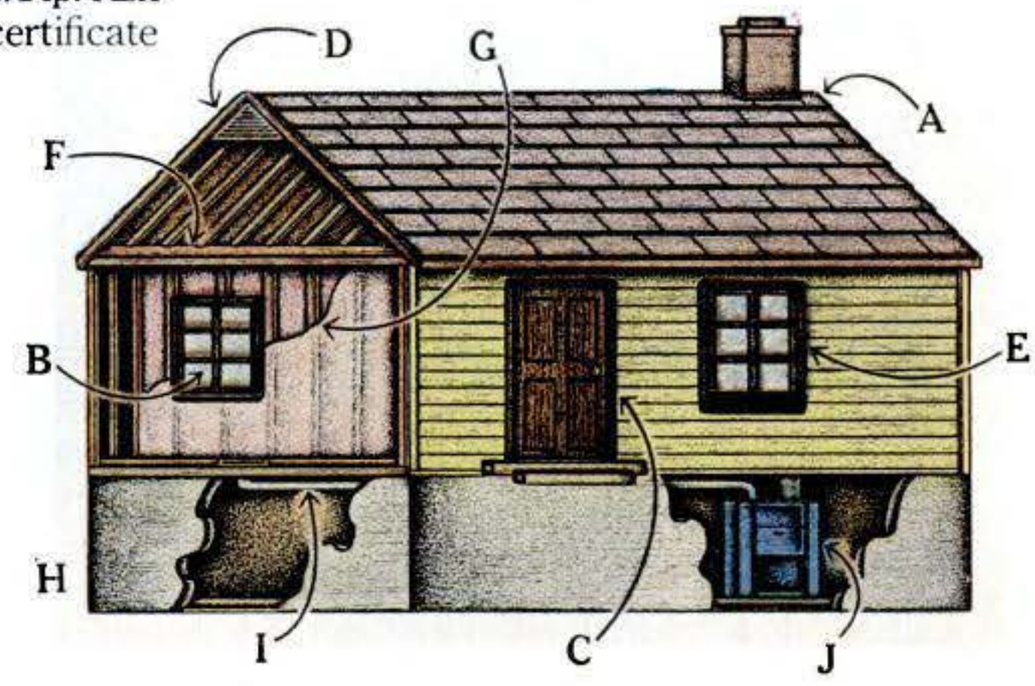
aying attic insulation with vapor ier on top. Wrong. Vapor barriers ld always face the warm-in-win- ide of the structure.

Insulation may be the last thing you need.

Insulation works best when it works in partnership with other home energy-saving ideas. Glance at that house diagram at the bottom of this column. It shows the ideal *combination* of 10 energy-savers suggested by Owens-Corning's thermal experts for newly constructed energy-efficient homes. You can still get the benefit of many of them in your older home: A. Caulking and sealing around doors and chimneys; B. Double-glazed windows, or equivalent (in certain geographic areas); C. Storm door and standard door used in combination, or an insulated door properly weather-stripped; D. Good attic ventilation to expel hot air and moisture; E. Windows weather-stripped.

Making a new home energy-efficient.

This diagram shows Owens-Corning's 10 specs for building a *new* energy-efficient home.



(Obviously, the best chance to do the job right.) It's a total *system* for saving energy and fuel bills—*at a cost which can be comparable to that of a conventional home!*

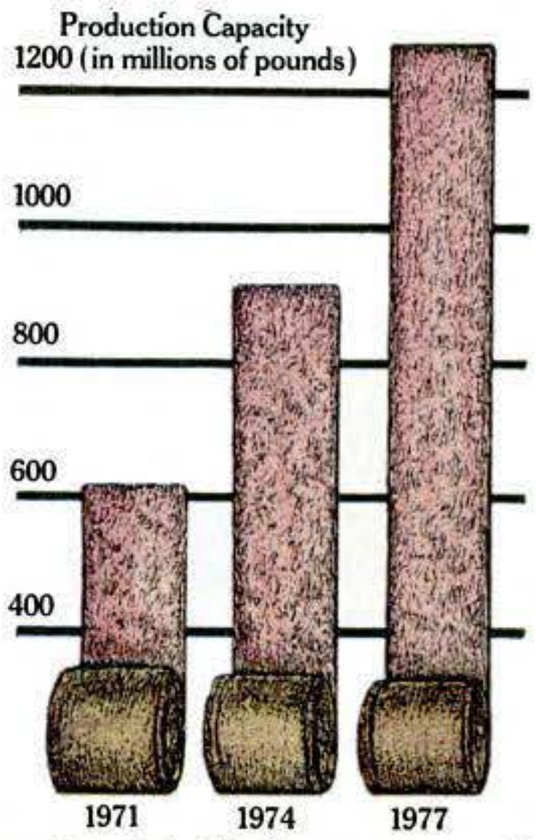
Besides A to E under the previous heading, specs include: F. Blankets of Fiberglas insulation—with NAHB Research Foundation label—installed to at least minimum R-values on map; G. Use of vapor barriers (1.0 perm or less); H. Perimeter insulation (for slab-on-grade construction); I. Certain air-handling ducts insulated; J. Correctly sized heating/cooling plant.

What to do if you can't get the insulation you want.

As the chart below shows, Owens-Corning has already *doubled* its output capacity since 1971, and we're planning to boost it another 35 percent by 1980.

Still, with millions adding insulation every year, there are bound to be shortages from time to time. Please be patient with your supplier if he's temporarily out of pink Fiberglas insulation. It's not his fault, and we're doing our best to minimize the problems.

We think Owens-Corning Fiberglas insula-



tion is worth a lot. Maybe, even, worth *waiting* for. But we have to be honest with you. If you have *no* insulation now, you're in trouble, and you should try to get at least a bit in your attic from another reputable manufacturer. Later, you can bring your home up to the minimums on our map with the brand you really want.

OWENS/CORNING FIBERGLAS

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Reflective draperies for a patio door

PS has had a number of queries about how the PS Lockbox—the pole-and-beam leisure home we built for a series of articles in 1975—fared last winter, since readers knew the house featured window-walls and electric heat. Though construction had begun before energy considerations became crucial, the house was properly sited (the all-glass prow faces south; the north wall is windowless), and all windows are double-glazed in factory-weather-stripped wood frames. Even so, heat loss through the window-wall on a 20-below night more than offsets the sunny-day solar gain.

So this year we're covering the windows with reflective thermal draperies each night (photo above) and whenever the house is shuttered between visits.

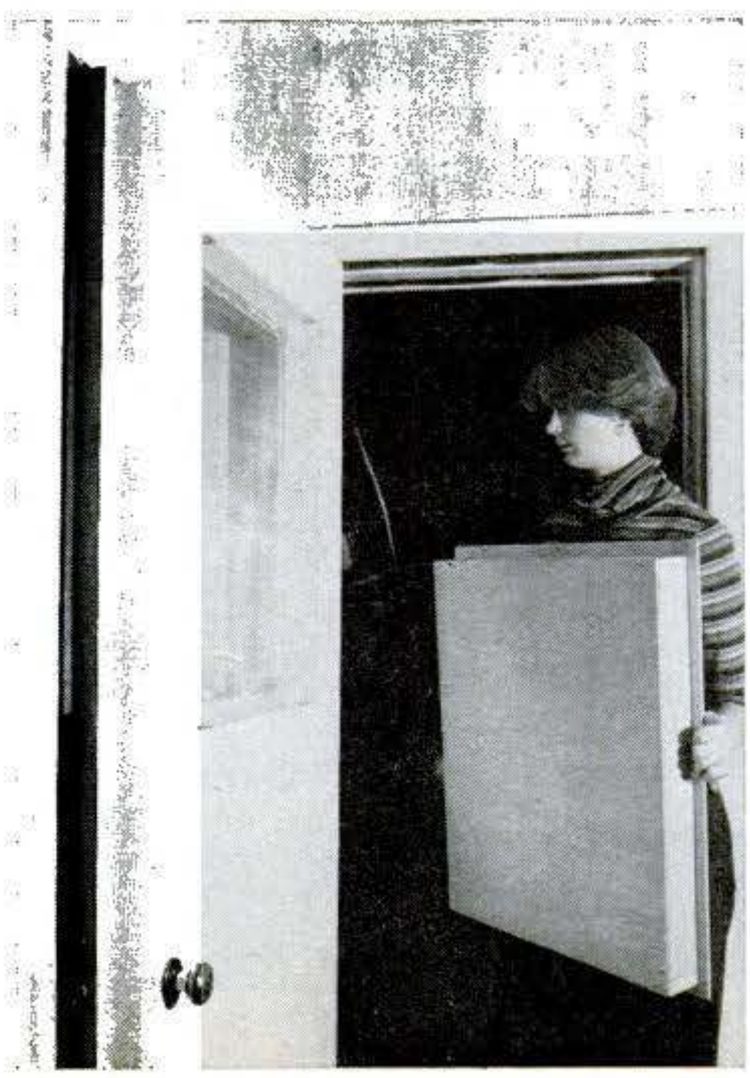
Guess what we're using for draperies? Thermos sportsman's blankets. These blankets come with a sturdy grommet in each corner that's easy to hook over L-screws in the door frames. The lightweight material is a tough, nonporous laminate (56" by 84") of fiber scrim and aluminized plastic film. Just be sure to place the reflective face *in*, where it can bounce back the room heat.

Blankets also prevent convection loss by keeping air from washing up the glass. For the most effective air seal, apply Velcro strips to overlaps and window frames.

We got our blankets from Edmund Scientific Co., Barrington, N.J. 08007; they're $10.95 each, ppd. Edmund also ships a cheaper, more fragile reflective sheet called a Space Rescue Blanket. It's the same size at one-fourth the weight, since it's just a single layer of metallized polyvinyl. It's not rugged enough for the use described above (and lacks corner grommets) but we've hung two pairs of these from a conventional drapery track, to pull across the upper tier of glass (not shown in our photo) each night. The thermal improvement when all that naked black glass is masked with reflective draperies is remarkable.—*Al Lees*

Door to unheated area:

Convert it to a thermal barrier



Completed attic door is shown above; insulated cover (left) snaps into place with bullet catches.

For more info on saving heat, turn page

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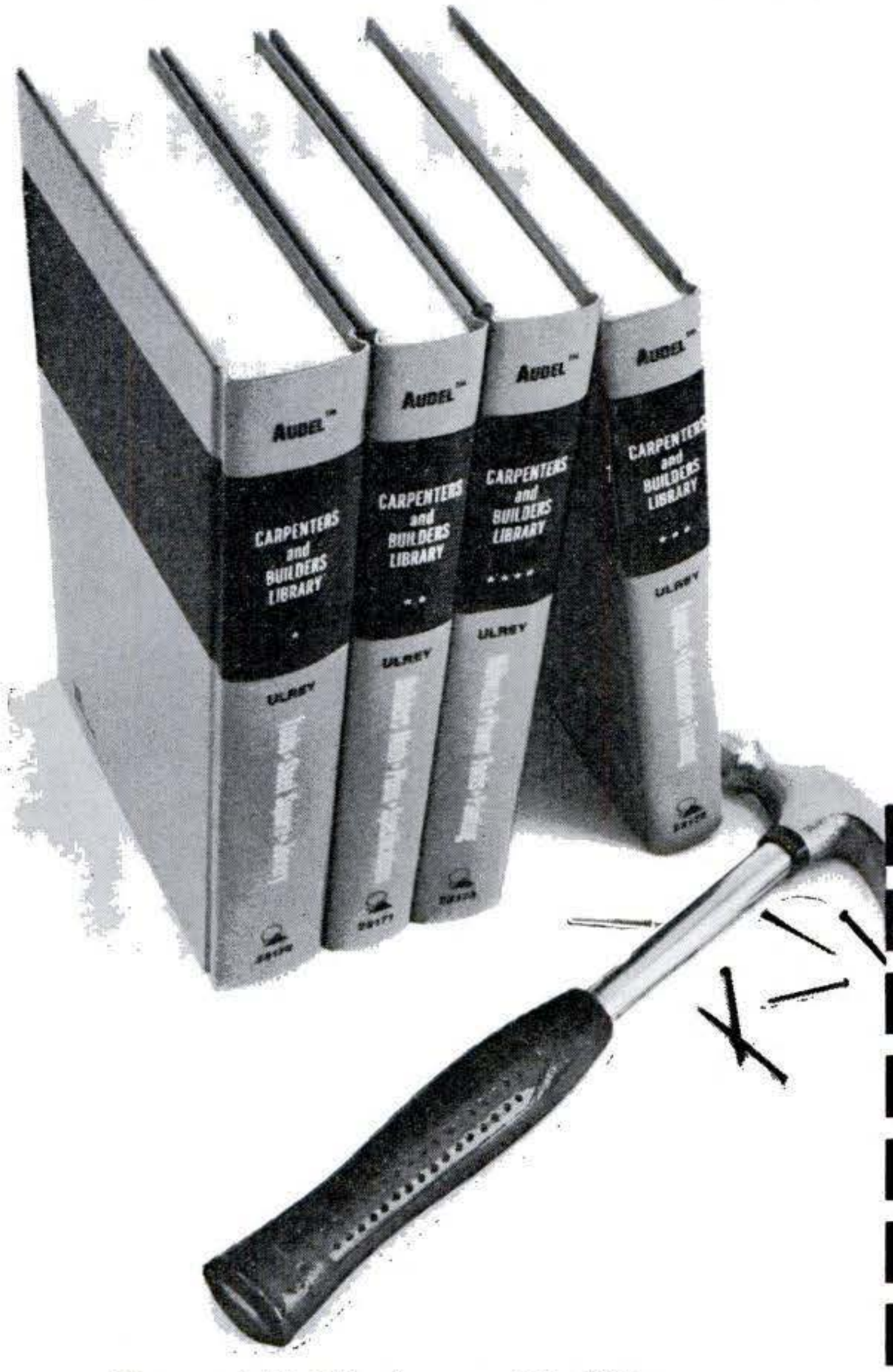

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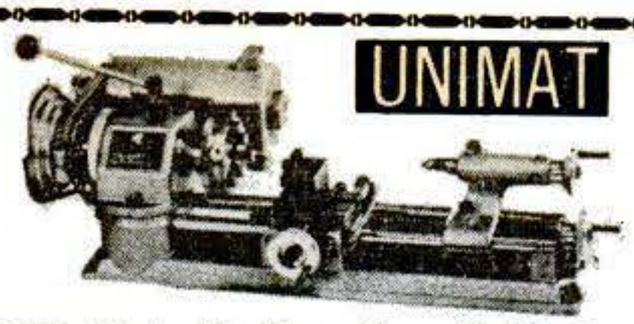

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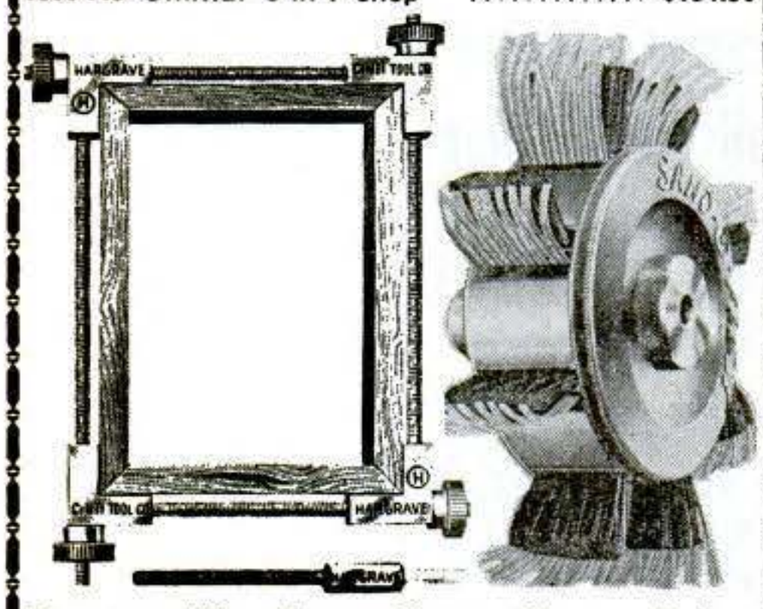

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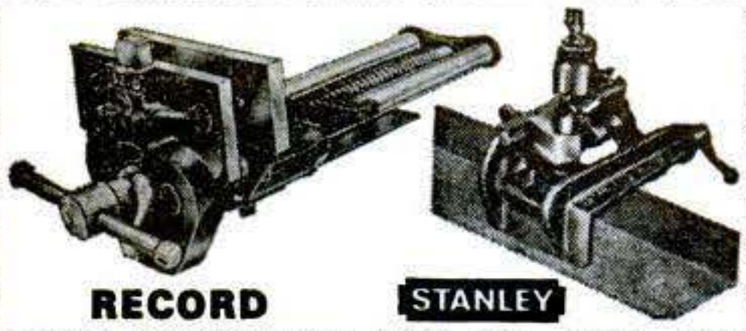

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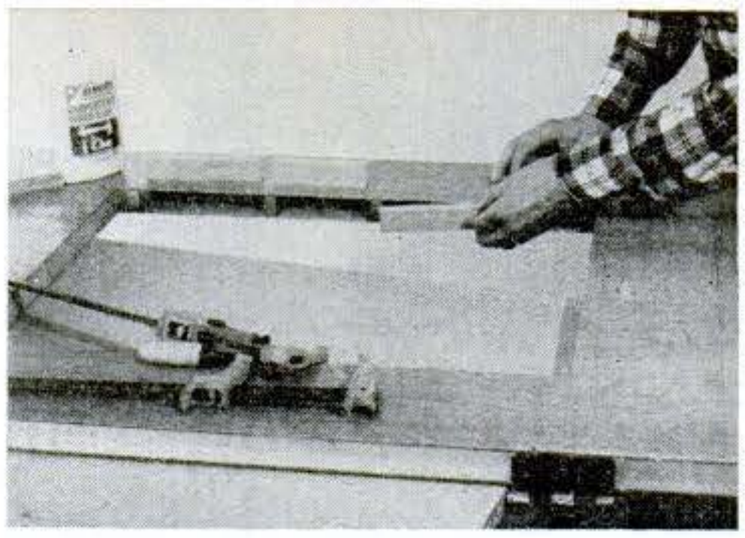
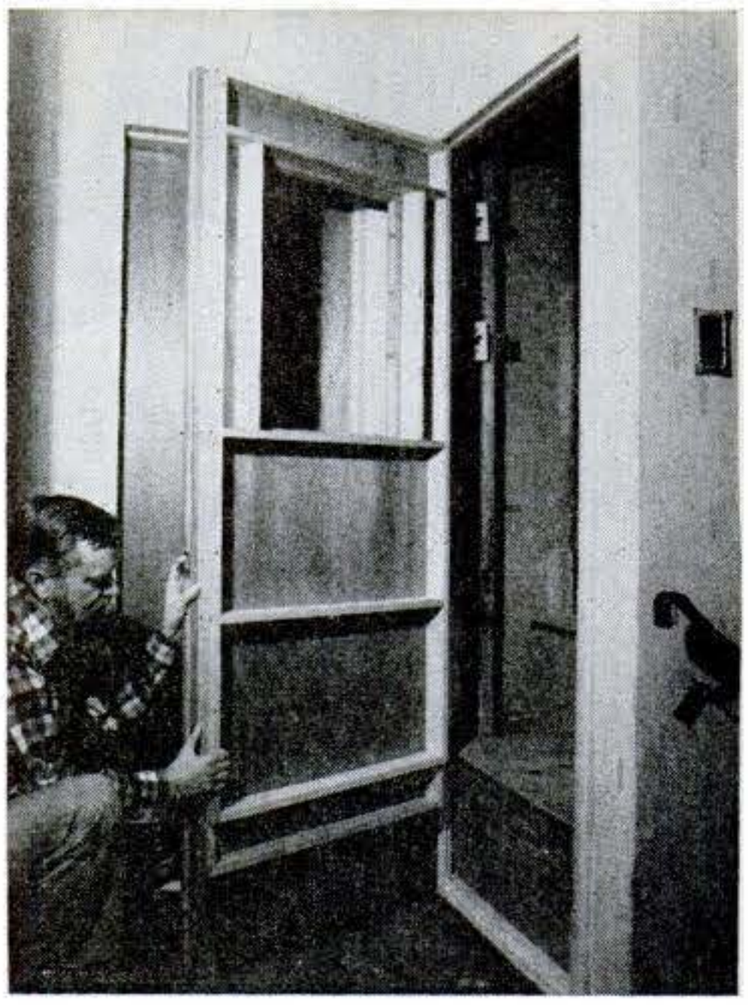
Heat-wasting doors

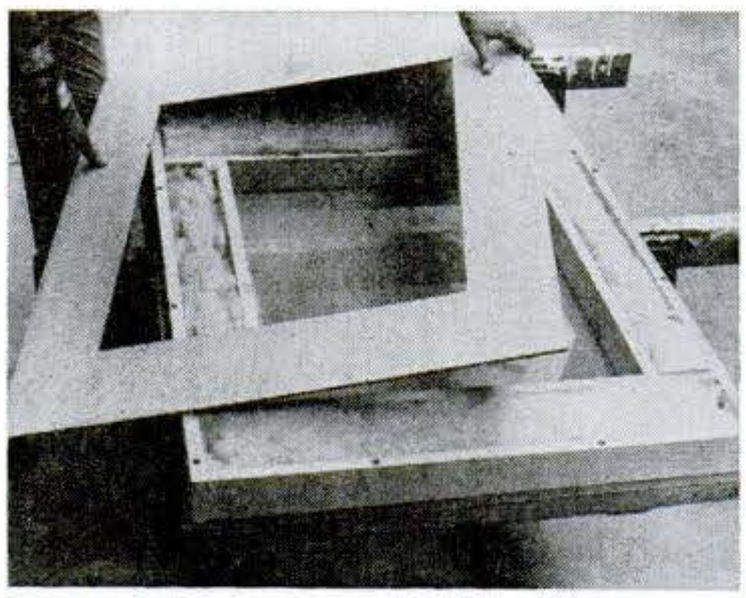
[Continued]



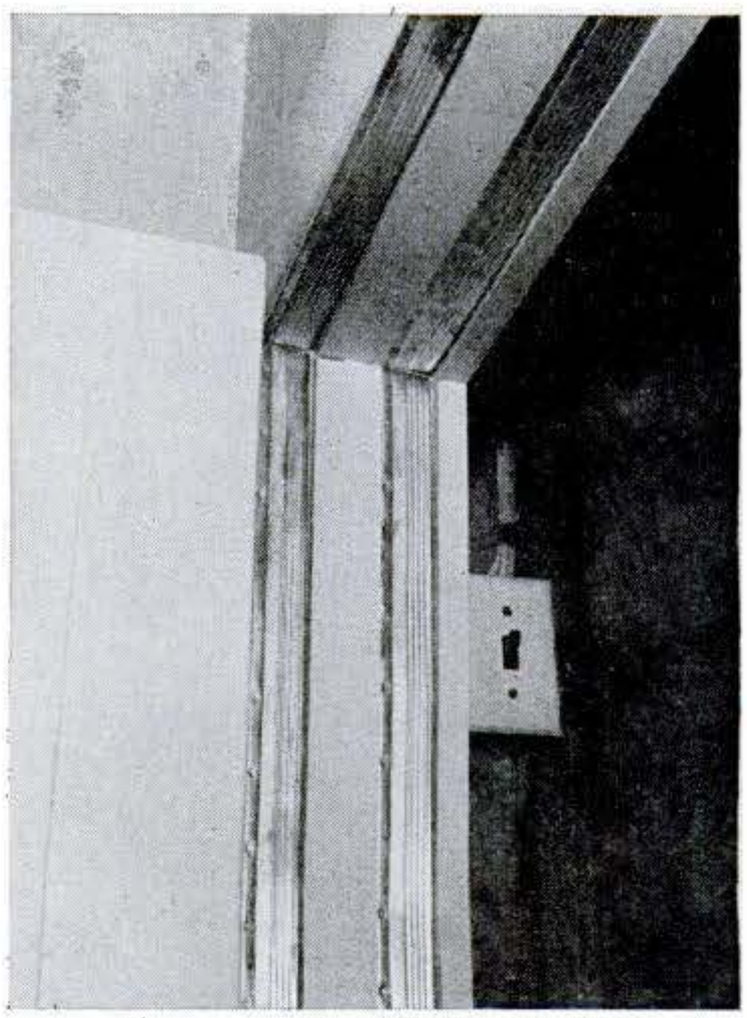
After cutting opening in hollow door for screened window, fill space between stiffeners with scrap wood blocking.



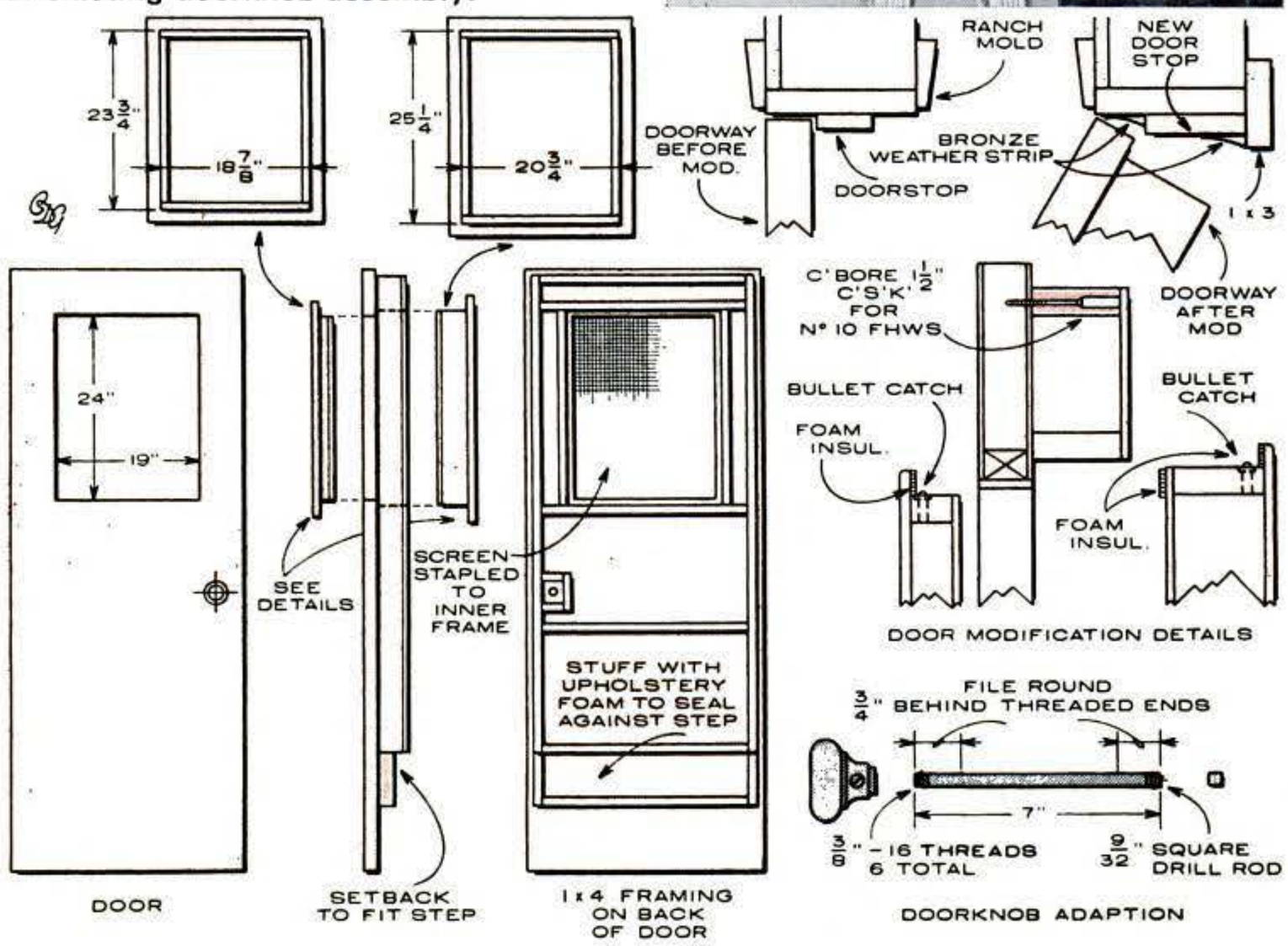
Framing of 1-by-3's to contain insulation is fitted to back of door. Framing is cut and notched at bottom to provide snug fit at first step of attic stair (also see detail in drawing below).



Fiberglass insulation fills all openings in framing except screened window. Plywood cover completes sandwich construction. Hardboard could also be used.



Doubled phosphor-bronze weather stripping seals top and sides of door opening (right). Longer rod permits use of existing doorknob assembly.



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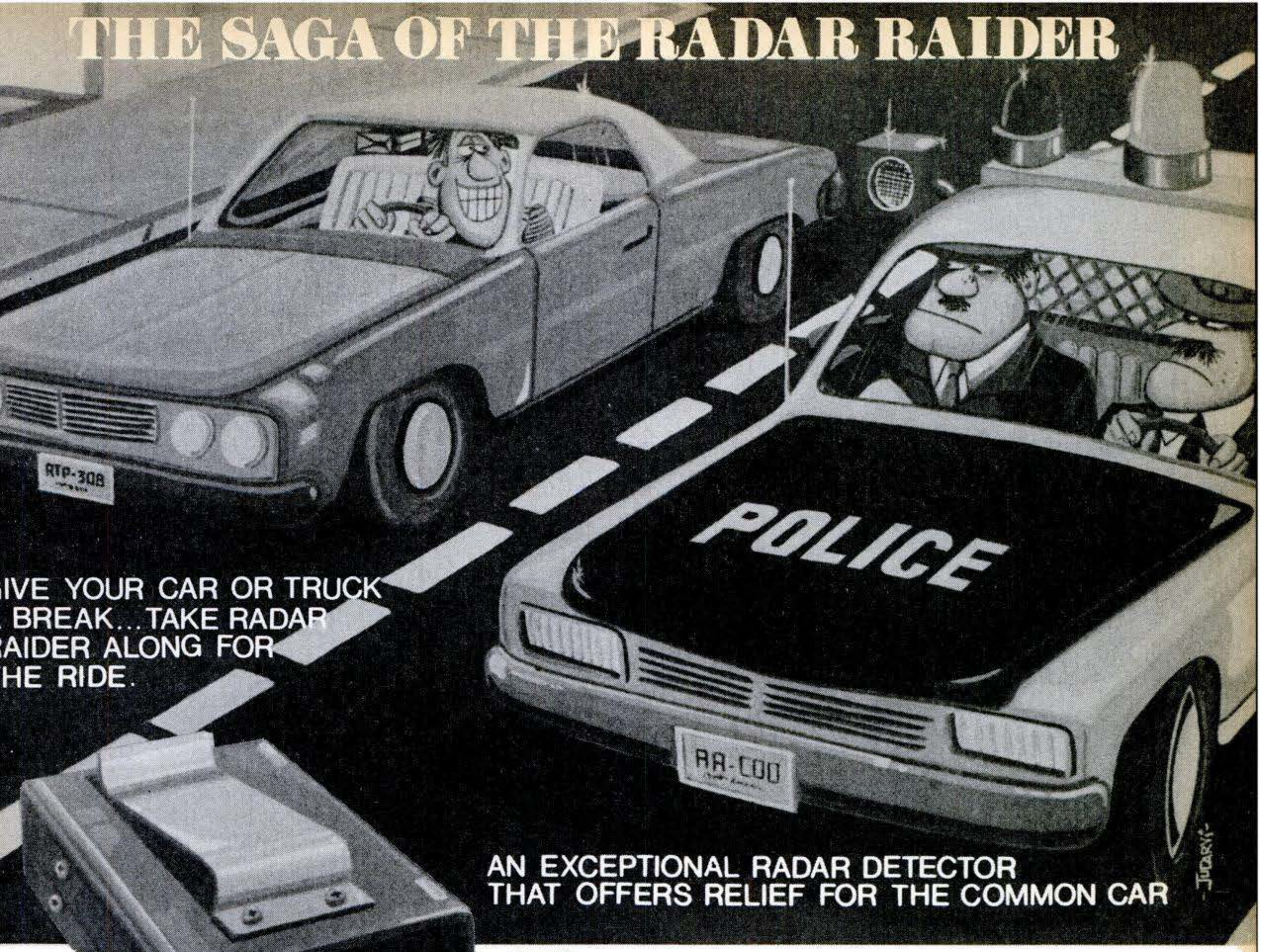

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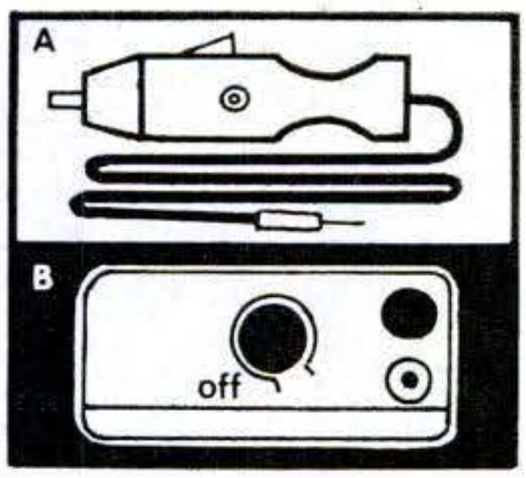

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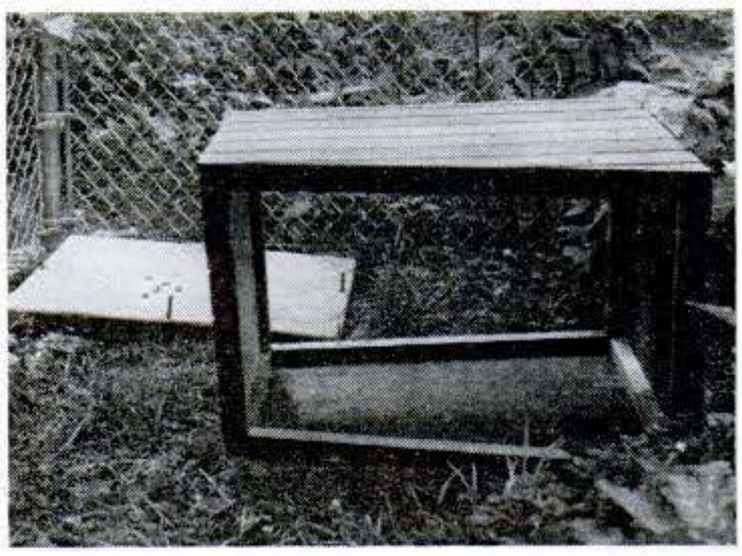
Rigid foam insulation, cut to fit within 2-by-2 frame, is cemented to sides and lid as last step, to keep inside cool.



Topless assembly is ready, here, to be tipped up onto slab; embedded bolts in background will pass through frame.

Fuel shed
stores flammables at a safe distance

Wary about storing those cans of gasoline and gas-oil mix for fueling lawnmowers and chain saws? They're potentially dangerous in a garage, and I wasn't even comfortable with them in my metal tool shed (which heats up in the sun).

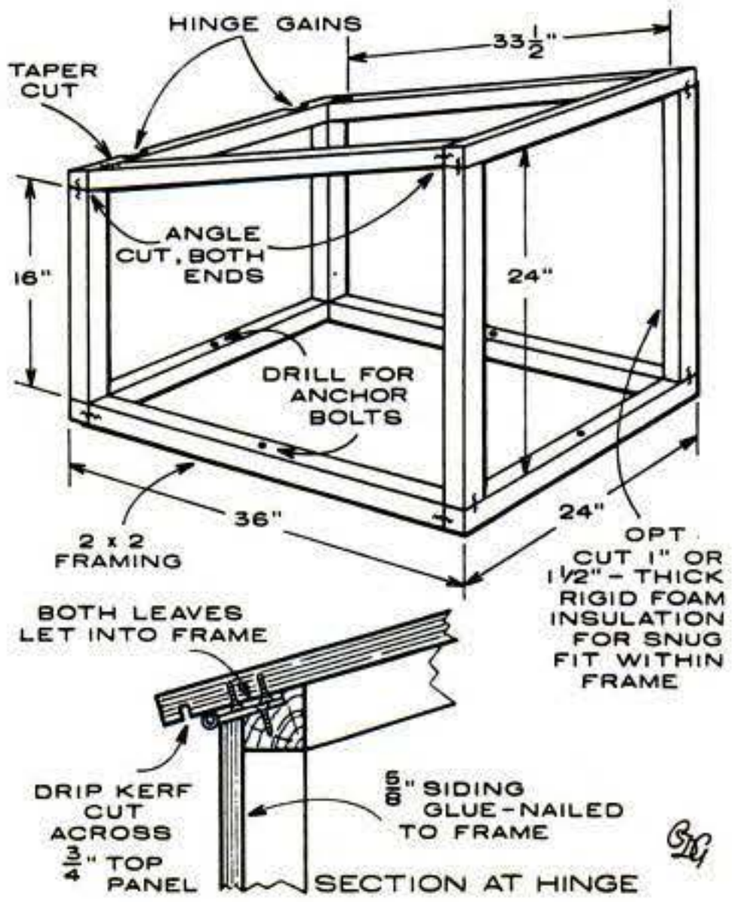
So, at the most isolated corner of my garden, I built this insulated shed from scraps of Non-Com-treated T1-11 plywood siding. The panels are fastened (with construction adhesive and galvanized nails) to a 2-by-2 frame, and this assembly is anchored to a 2-by-3-ft. concrete slab with four anchor bolts.

Best procedure is to build your frame first, cut the panels to fit it—but be certain to attach the panels so they project at least ¾ inch beyond the bottom frame. This lets them lap the slab for a watertight joint when the frame is snugged down on those bolts.

Finishing the panels to match your house siding makes this little outbuilding look right at home.

For the hinged lid, I used ¾" MDO plywood, coated with neoprene deck paint, but you could substitute construction-grade plywood surfaced with roll roofing. To assure a snug, watertight fit, I left a ¾" lip at front and sides, and glue-nailed strips of ⅝" quarter-round molding to the underside. At the back, I left an inch overhang and (since a molding strip here would interfere with the pivoting action) I ran a saw kerf across, just outside the hinge-barrels, to prevent any leak-back of the runoff. To the underside of the lid, I cemented a panel of rigid insulation, cut to fit within the top frame.

In the center of the front edge, I applied a padlock hasp. Note that when the lid is closed (left), no screws can be removed from hinges or hasp: good security.—*Al Lees*



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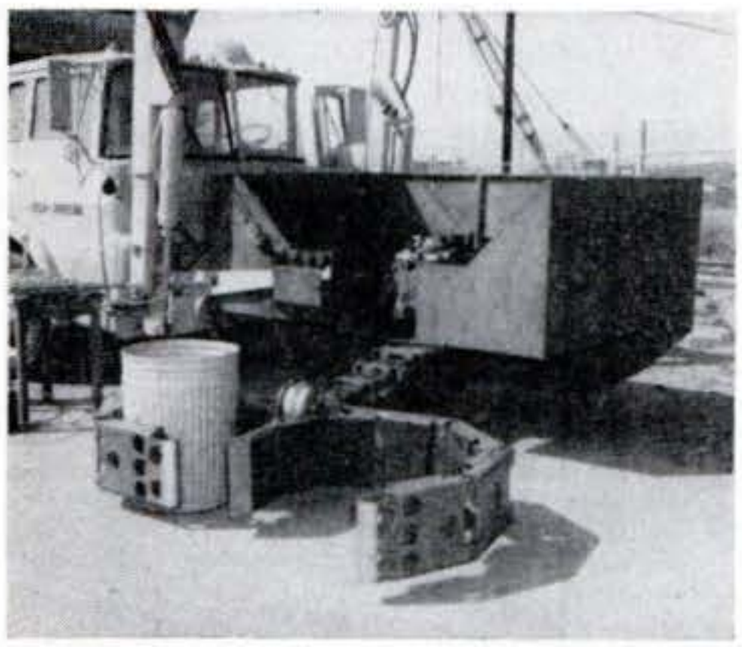
Garbage grabber
collects trash fast

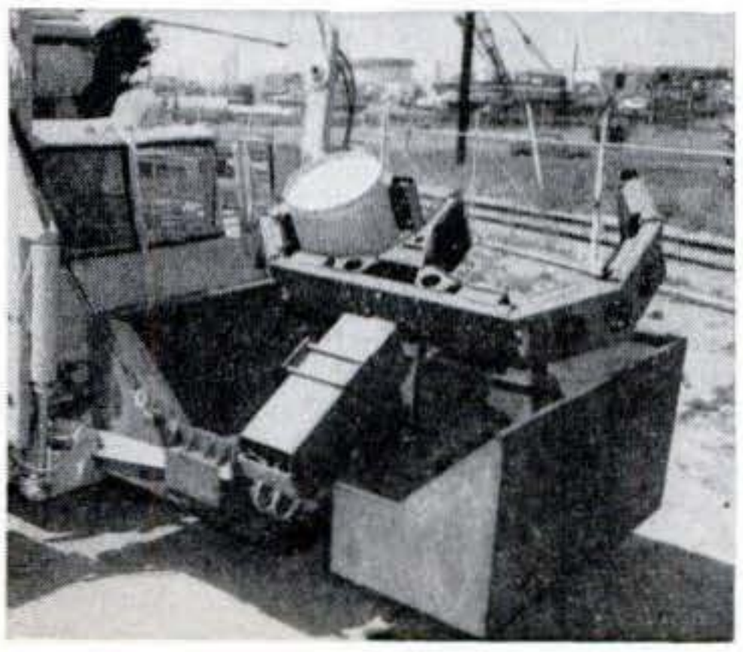
If you wake up one morning and see a huge metal hand lifting your garbage can to the sky, don't panic. It's not a monster; it's progress. The "hand" is part of a rubbish-pickup device developed by the Navy's Civil Engineering Lab in Port Hueneme, Calif. The device attaches to industrial refuse trucks to convert them for handling residential trash.

The hand that picks up garbage cans and dumps them into a bin is on the end of a hydraulically powered telescoping arm. The arm has a seven-foot reach and can move up, down, and sideways. Since the jointed fingers grasp like thumb and forefinger, they can pick up cartons and bags, as well as cans. A control valve regulates pressure as the foam-padded fingers grasp the container. The device sets the cans down gently on the ground, so the cans stay in shape longer and trash day is less noisy.

Collection is also quicker. As one set of fingers drops an empty container, another set can pick up the next full one. The arm is guided to the garbage by the operator, using a simple joystick. But retraction of the arm and dumping into the bin are automatic.

According to CEL, installing the unit on a truck takes less than 10 minutes. Besides being a time-saver, the mechanical device could also save money. It enables one truck to do the work of two—an industrial and a residential refuse truck. CEL estimates that the device will cost about a fourth the price of a conventional garbage truck.—*Rochelle Chadakoff*





Garbage grabber grasps can (left); arm retracts (left below) and empties can into bin. When bin is full, its contents are dumped into the truck (below).

What every stubble bum should know.

The closer you cut your stubble, the longer it takes to grow back. The longer it takes to grow back, the less likely you will look like a stubble bum before you have to shave again. Which brings us to Mennen Skin Bracer® Pre-Electric Shave Lotion. It tightens your face, conditions your stubble so you can shave extra close. It even helps lubricate your razor head, and it's got that clean Skin Bracer fragrance. Congratulations. You are soon to join the ranks of the ex-stubble bum.

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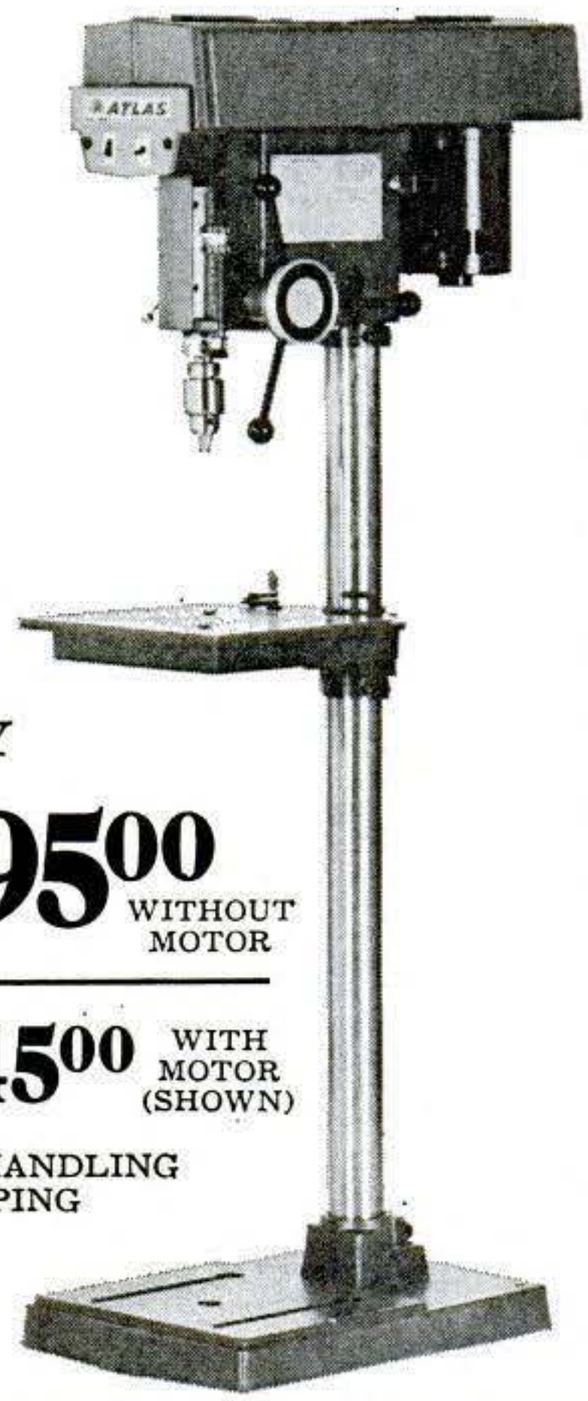

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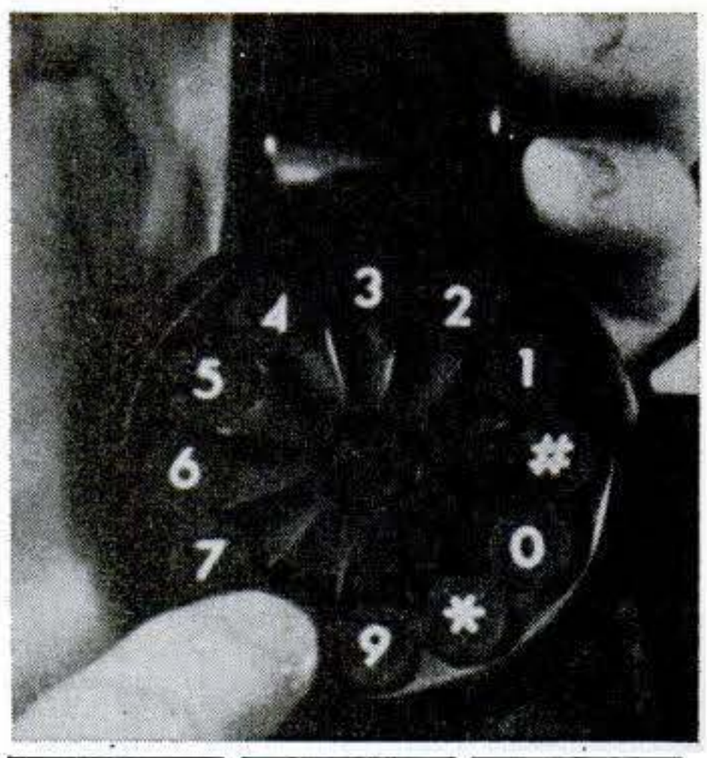

Remove your present mouthpiece, screw on Soft-Touch

HERE'S HOW YOU SAVE

You install Soft-Touch yourself—so there's no installation fee. The device fits into the mouthpiece of any standard wall or desk telephone, single or multi-line. Simply unthread the old mouthpiece and screw in Soft-Touch. That's all there is to it. Soft-Touch is completely compatible with all tone-capable telephones. (You can verify if tone service is available in your area by just calling your local telephone business office. If they say your area is tone capable, order Soft-Touch and save those monthly charges.)

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*Touch-Tone is a registered Trademark of AT & T. Soft-Touch is a registered Trademark of 2001 Telephone Systems. You may wish to check with your local telephone company regarding installation.

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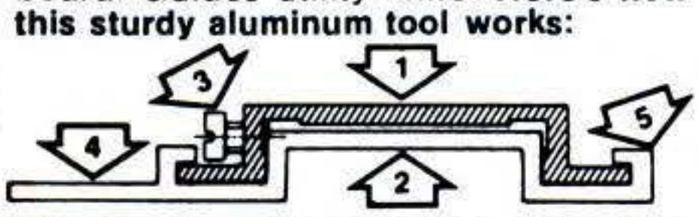

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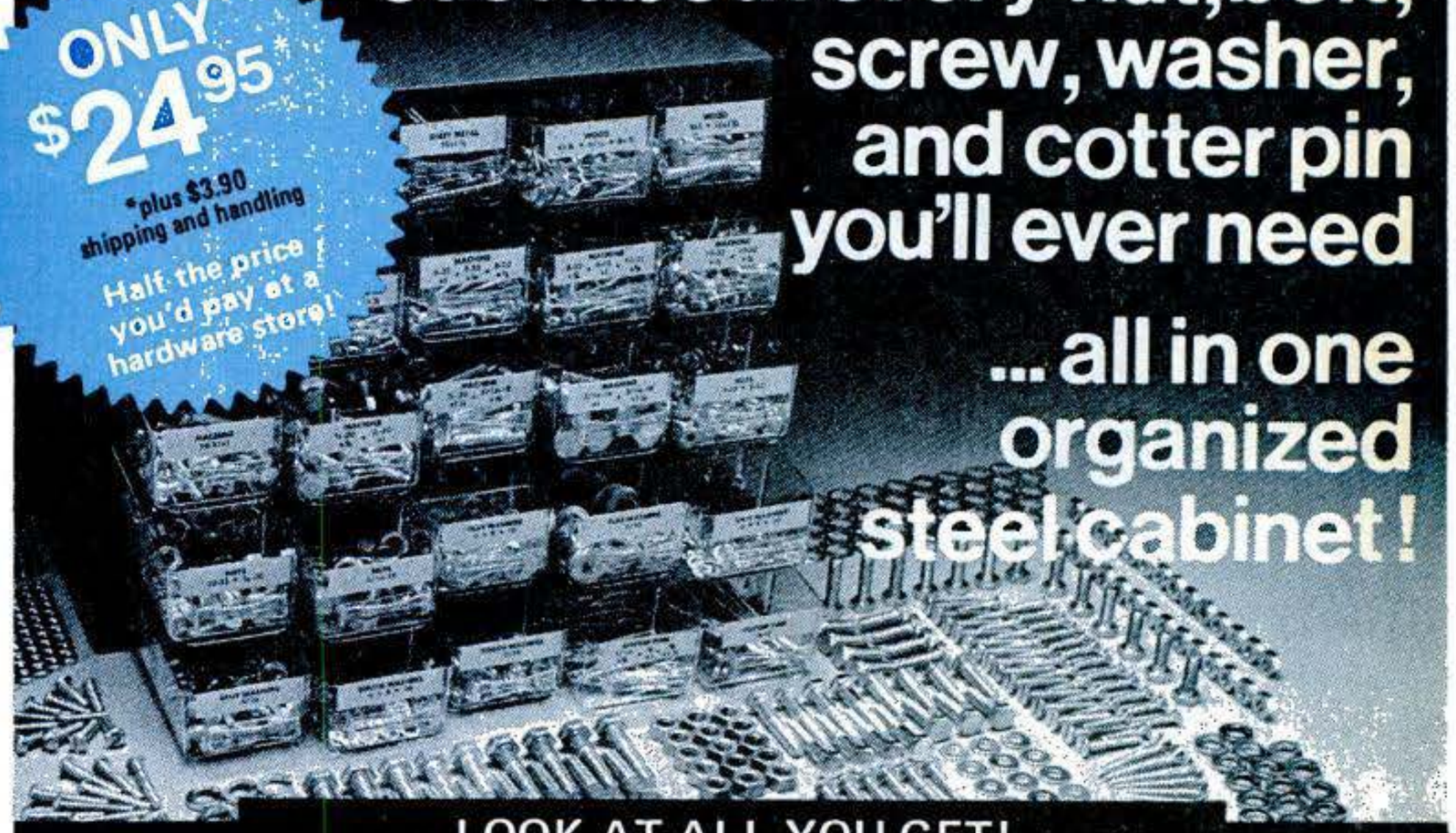

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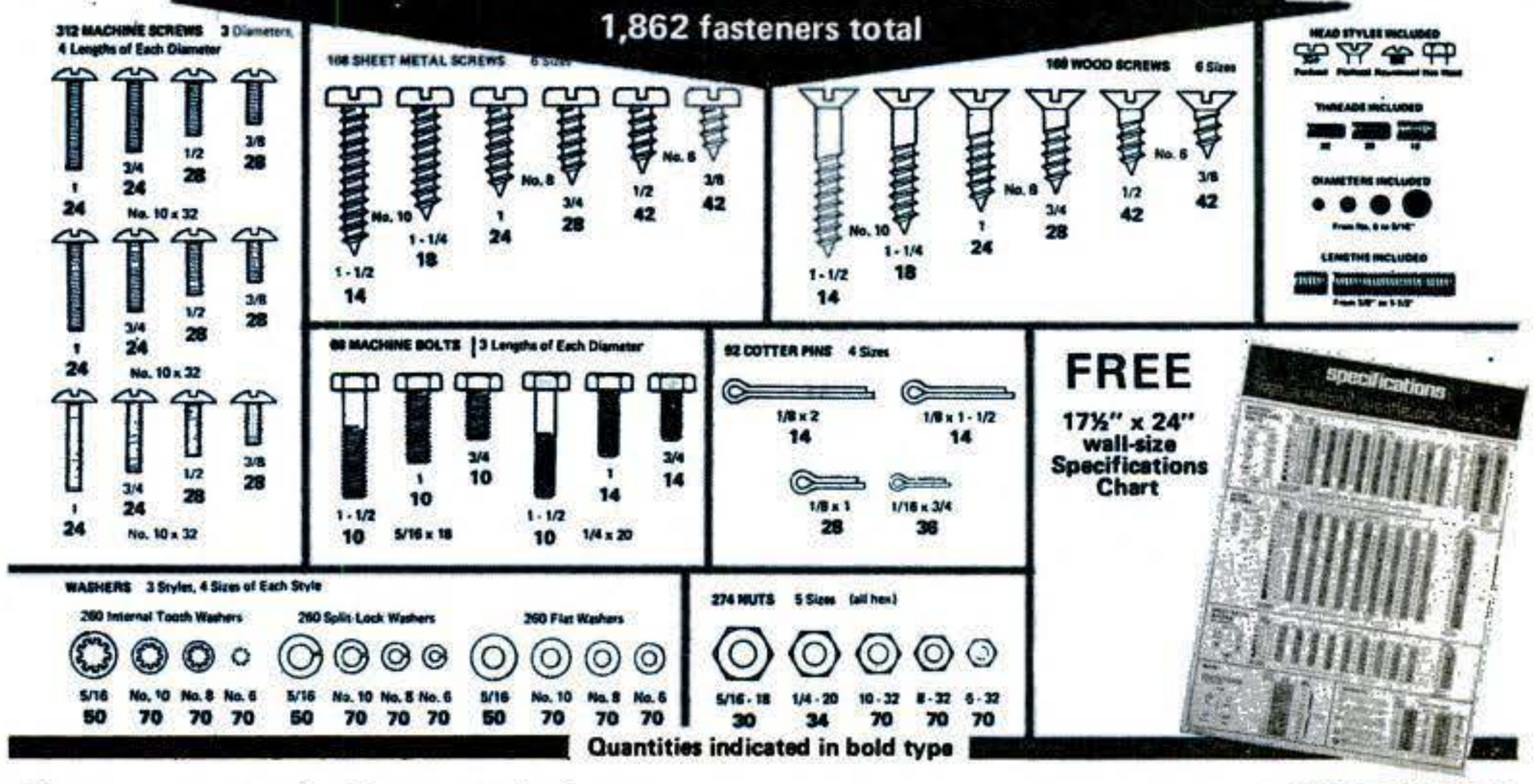

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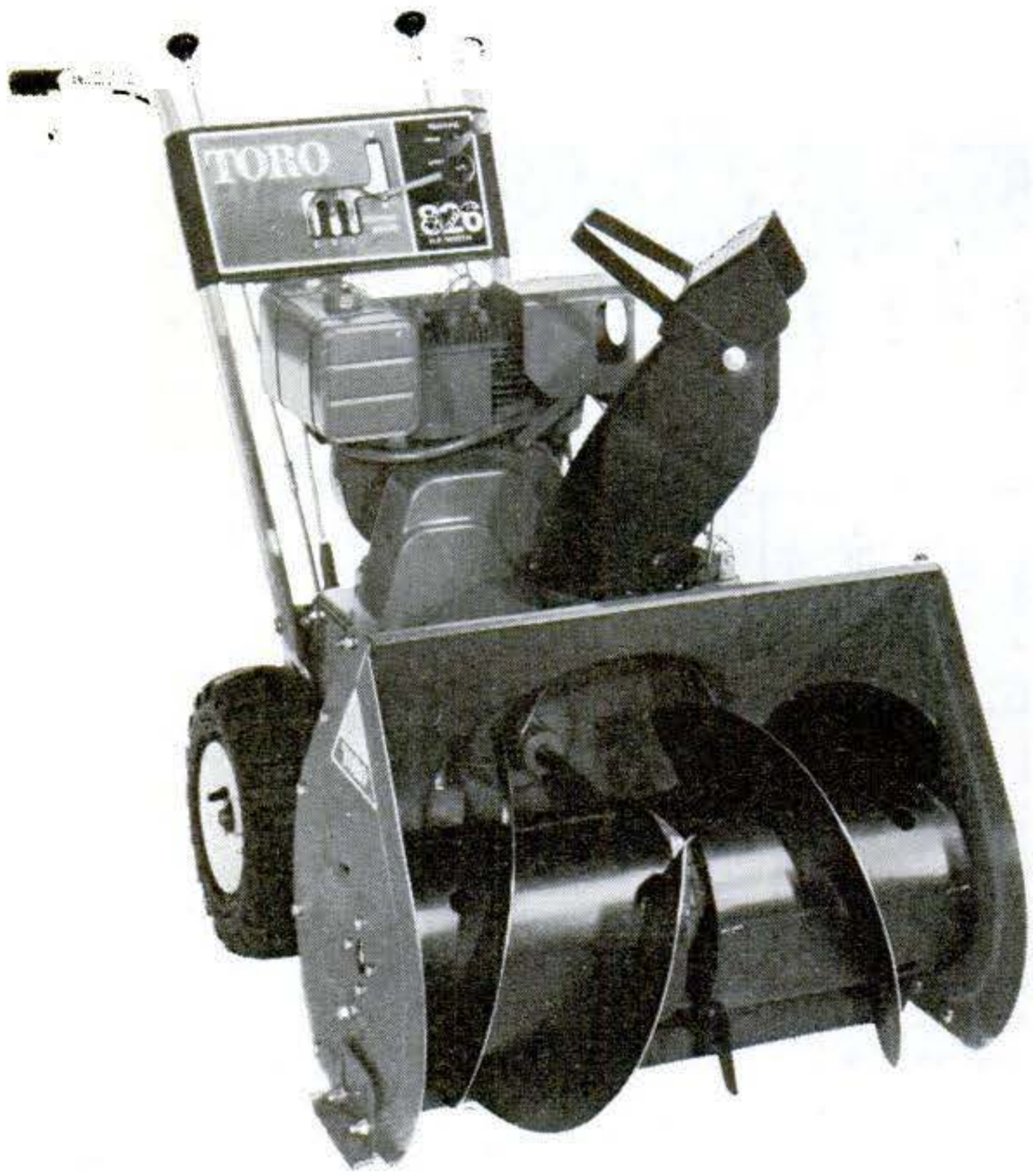
The facts (and myths) about snowthrower safety



Single-stage snowthrower, like the Gilson at top, has fast-moving auger that cuts snow and forces it out chute. Note propulsion and auger clutches on handle, covered drives, muffler shield—all good safety features. Two-stage machine, like Toro (above), has auger, plus high-speed impeller at base of chute. This model, designed for safety, has interlock controls that automatically stop auger as well as forward motion when you release handgrip.

By E. F. LINDSLEY

Stick your hand into your snowthrower's discharge chute to free packed snow? "Never," you say—but that's how at least 83 percent of the estimated 13,100 snowthrower injuries over the past four years happened. Most of the victims suffered severe injury to fingers, hands, or arms; many even lost digits and limbs. Most snowthrower accidents are totally preventable. But to prevent them, you must know how and why they happen. Here are some of the problems.

First, snow removal is usually done in a hazardous environment. Disorientation in the cold and wind, snow-plastered glasses, cumbersome clothing, and the obvious potential for falls all contribute to accidents. Fighting wet, sticky snow, especially, can soon reduce you to a state of frustration and fatigue. Many accident victims said they were "tired, in a hurry, and impatient."

Lack of practice is another problem. Snowthrowers are used so infrequently that most users don't become as familiar with them as, for example, with a lawn mower. Quite a few accident victims are either first-time operators or are using the machine for the first time that winter. And often the inexperienced operator simply doesn't understand how the machine works. Although snowthrower manufacturers are doing a number of things to reduce inherent hazards, the fact remains that human oversight is the prime cause of accidents.

What you can do

First, take a long, careful look at your snowthrower—in fair weather and good light. Pay particular attention to these most hazardous parts: (1) the rotating auger, or perhaps a paddle, that gathers the snow; (2) the high-speed impeller behind the auger on two-stage machines; and (3) exposed chains, sprockets, belts, and drive shafts. Learn the exact location of all these parts, and learn how they work. Then plan your operating procedures to minimize your exposure to the working parts.

If your snowthrower is a single-stage model, either a walk-behind or tractor-mounted, the auger does double duty, both cutting up the snow and feeding it out the chute. This means the auger must turn fairly fast, and the area in front of it is very hazardous. Get

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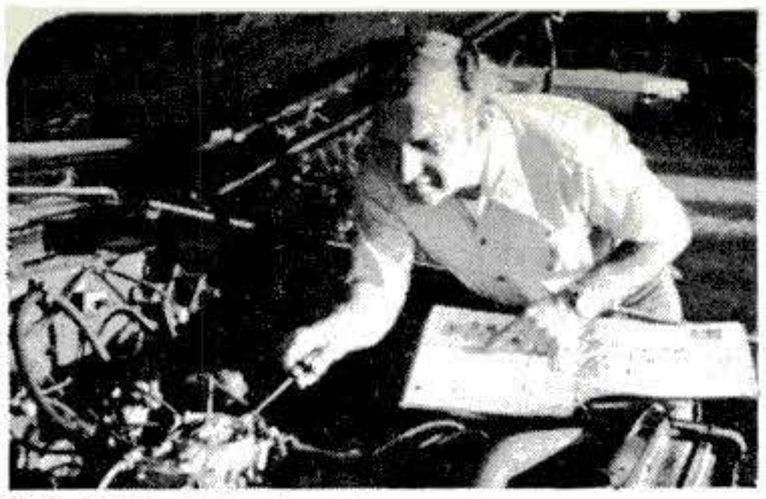

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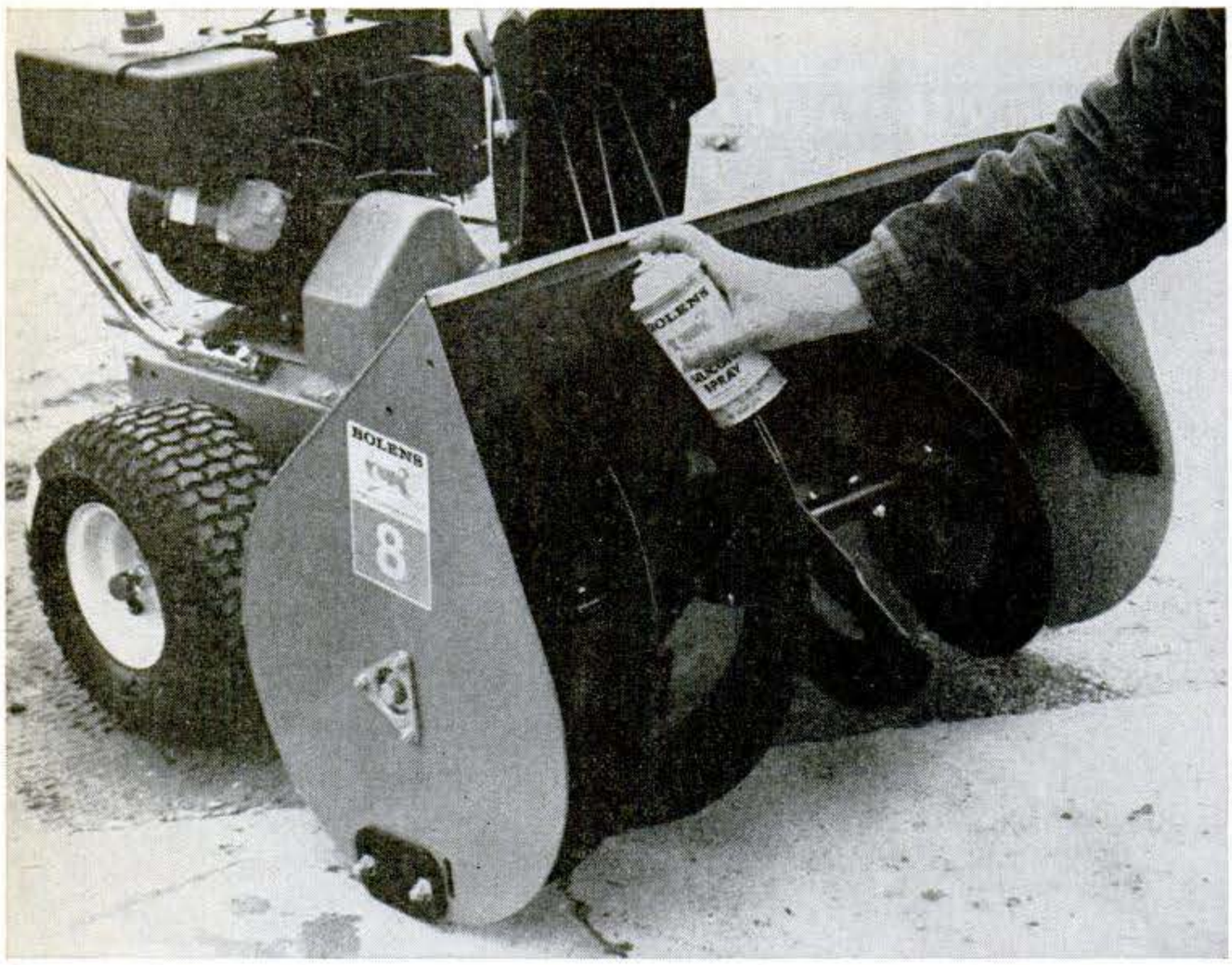

Spray silicone lube inside scoop and chute to make ejection of wet snow easier. Smooth and paint bare spots, as such rough areas can start clogs.

too close and the auger can snatch your clothing, chop your foot, or just give you a nasty wallop.

A good snowthrower will have a propulsion clutch that stops the machine instantly when you release the handgrip. Theoretically, you can safely walk ahead of the machine to pick up a foreign object. In real life, however, clutches fail to disengage completely and vibrate back into engagement. People slip and bump the control, or sometimes put a hand against it for support.

So don't depend solely on the propulsion clutch to protect you from the auger. Your rig should have a separate auger clutch. Plan always to drop it out, as well, before you venture in front of the snowthrower. If the auger clutch is down on the chassis somewhere, be sure you can operate it without coming near a belt, chain, or hot muffler. Practice with mittens on and work out a motion so you can disengage both clutches without awkwardness, and without supporting yourself on the chute, engine, or scoop.

Dangers of two-stagers

Two-stage snowthrowers (in my experience, more effective snow removers) have an impeller behind the auger, and it's the impeller that's the greatest hazard here. On two-stagers, the auger turns quite slowly, although it's still nothing to try to clean by hand while it's turning. The slowness is deceptive, and the power is irresistible once you're in its grip.

All told, two-stagers cause more hand injuries than single-stage machines. Under the chute, where it's hard to see, the rotating paddle wheel or impeller runs at high speed in order to throw the snow out the chute. Be aware of it. Some victims claimed they didn't even know it was there. Many didn't realize how close it was to the bottom of the chute—it may be only two inches away. Others thought that it stopped when the machine stopped moving forward and the propulsion clutch was disengaged. (Of course, it can't work that way or you'd never be able to stop forward motion to wait for the scoop to clear—a necessary procedure.)

Try the auger clutch, in and out. See if the impeller coasts for a while after you disengage the clutch. Quite a few fingers have been nipped by a coasting impeller, even when the victim had disengaged the auger clutch. In some instances, the clutch drags enough to keep the impeller turning, and occasionally the user accidentally bumps or leans against the clutch while cleaning the chute.

A chain drive or V-belt and pulley that no one in his right mind would place his hand near in daylight can lurk unseen and unthought of on a snowy night. Learn their location and how they move. Naturally, you should be certain that all guards are securely in place.

Proper dress

Your clothing is also important. Unless you're accustomed to working with machinery, you may find it difficult to visualize how a rotating drive shaft on a tractor-mounted snowthrower, for example, can wrap up a mitten, scarf, or coattail almost instantly. A worn-out hunting jacket with loose pockets, straps, and belts, or an ancient mackinaw, is not ideal snow-removal garb. I wear a snowmobile suit since it has no dangling tail, fits snugly at sleeves and ankles, and requires a minimum of bulky sweaters underneath. Good boots with a non-slip tread and the mittens you can get from your snowthrower dealer complete a safe outfit.

Safe operation

Presuming you've studied your snowthrower, learned how it works, spotted possible danger points, and fitted yourself with safe clothing, are there techniques in handling your snowthrower that can make for safer operation?

"Emphatically, yes," says Rich Heidner, product manager for Gilson Brothers Co. He offers these suggestions for safely operating in wet snow, the most difficult kind.

- Operate with the chute deflector fully up and with reduced power. Most users run at full throttle and then drop the chute deflector to control where the snow goes. Having the deflector fully up avoids putting what Rich calls a "kink" in the snow, and this reduces the clogging tendency. The reduced throttle keeps the snow from going too far and works fine for all but very low-power machines.
- Operate with forward speed as fast as possible; use high gear. By moving fast you keep forcing snow into the auger, and this applies more pressure to the snow that wants to stick in the chute. And the sooner you get after the job the less packing and slush formation—and clogging—you are likely to encounter.
- Watch for the beginnings of a plug, and when you see one forming, quickly swing the scoop of the

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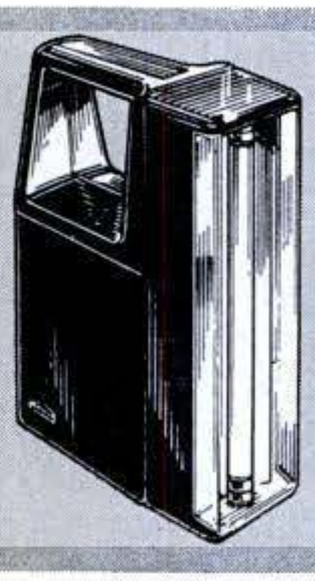

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Snowthrower safety

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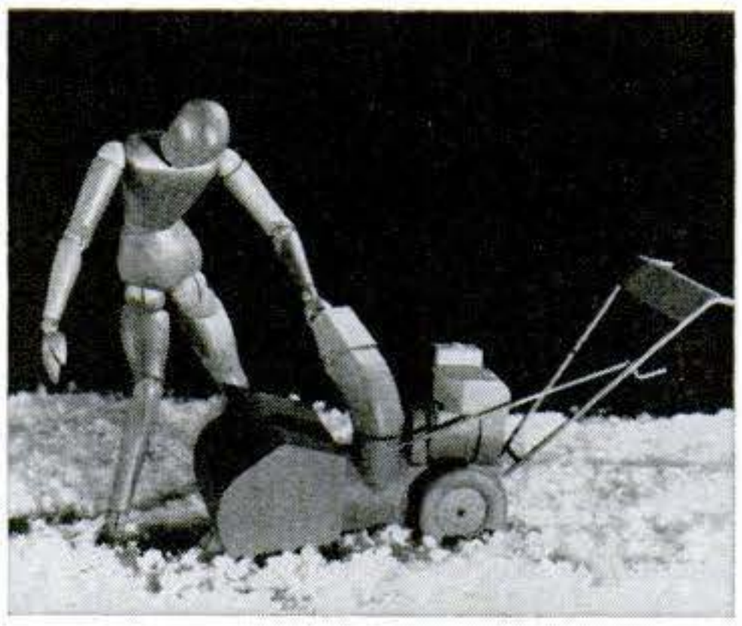

Three don'ts and a do: Wooden Head is reaching for an accident (top left). He's clearing chute with his hand, has his foot in front of the auger, and is standing in front of chute so anything that sails out will hit him in the face. Top right: Woody kneels to get his arm farther down chute—while he braces his left hand in control area where it could nudge clutch into engagement. Lower left: Poor Woody has an adjustment problem and embraces machine so he can work clutch with one hand and with the other feel what's wrong. If this doesn't get him, his long scarf will, or he'll burn himself on the hot muffler. Lower right: Woody does it right. He clears chute with a stick, keeps his feet away from auger and his hands away from clutches—and leaves scarf home.

snowthrower into a deep bank. This will fully charge the auger and impeller and should push out the plug. Never, of course, use your hand to clear the chute.

Not all these techniques work perfectly all the time, but they will help most of the time. Practice them and find what works best.

I have a few suggestions to add to Heidner's.

- Use a spray-type silicone lubricant to coat the auger, the inside of the scoop, the impeller, and particularly the inside of the discharge chute before each use.
- Stop at the lumber yard and pick up some softwood sticks, which are normally available for the taking where trimming is done. Something an inch square, more or less, and about a yard long, is about right. Always use a stick instead of your hand to poke out a plug in the chute. If you happen to hit a turning impeller (and you should have the clutch out so it isn't turning), all you'll get is a harmless clatter.
- Third, never try to repair or adjust a drive or other part while the engine is running. As a matter of good practice, disconnect the spark plug so a casual tug on a belt doesn't flip the engine over.

Built-in safety

If you're buying or renting a snowthrower, be sure to look for the latest safety devices:

- Chute guards.
- Interlocks that cut forward motion and impeller/auger action when you release your grip.
- Auger/impeller brakes that cut spinning time to under five seconds.
- All controls at hand.
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What you won't find built in is the patience and common sense needed to safely operate any power machine. Supply that yourself—for safety's sake. PS

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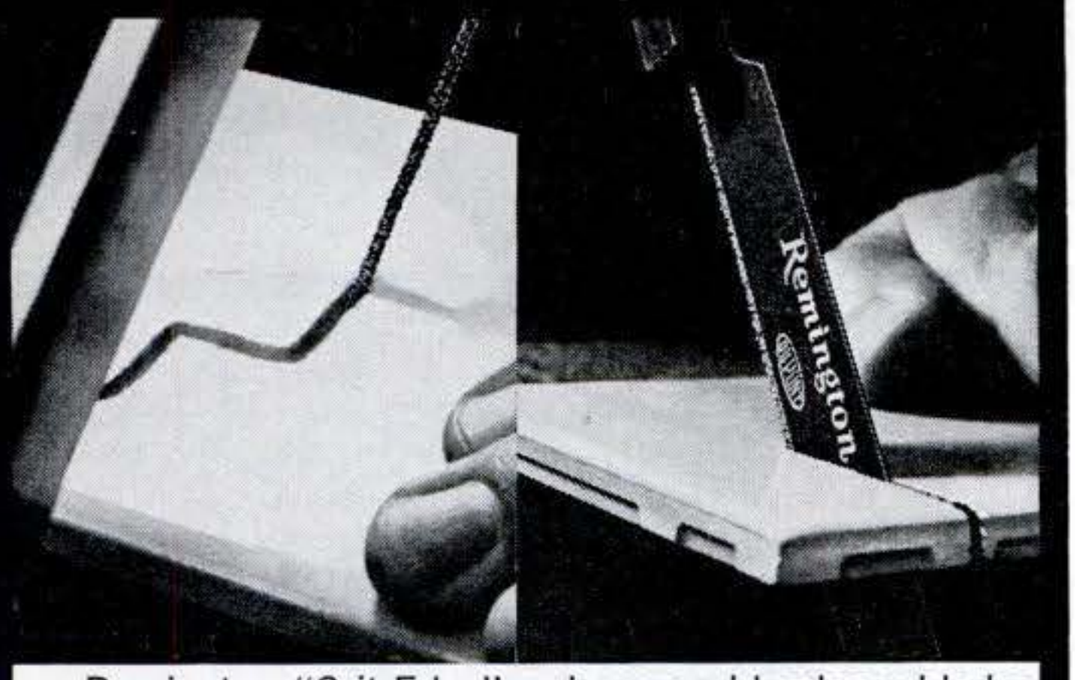
"Grit-Edge" blades trim tile with style.



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Beryllium	X	X			X
Carbon	X	X		X	X
Cast Iron	X	X			X
Composites	X	X	X		X
Composition Board			X	X	X
Fiberglass	X	X	X	X	X
Foamed Glass	X	X			X
Friction Materials	X	X	X	X	X
Glass	X	X			X
Hardened Steel	X	X			X
Honeycomb Materials					X
Marble, Natural	X	X	X		X
Marble, Synthetic	X	X	X	X	X
Plaster			X	X	
Plastic Laminates	X	X	X	X	X
Plywood			X	X	X
Stainless Steel	X	X	X*		X
Stranded Cable	X	X			X
Superalloys, Iron-base	X	X			X
Superalloys, Nickel-base	X	X			X
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Tires, Steel-reinforced					X
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Tile, Ceramic	X	X	X		X

*Requires coolant and variable – speed machine

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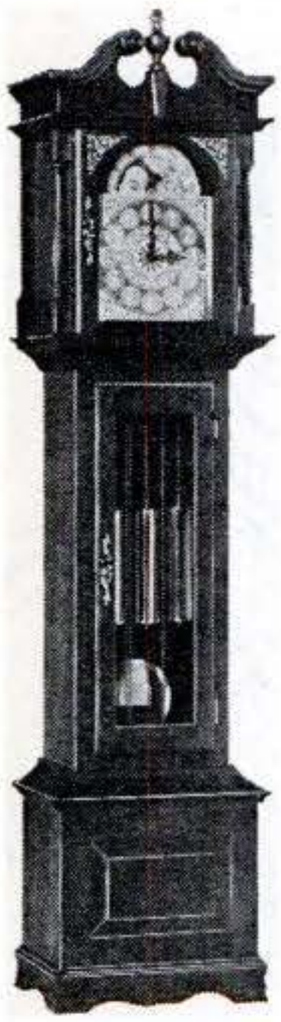

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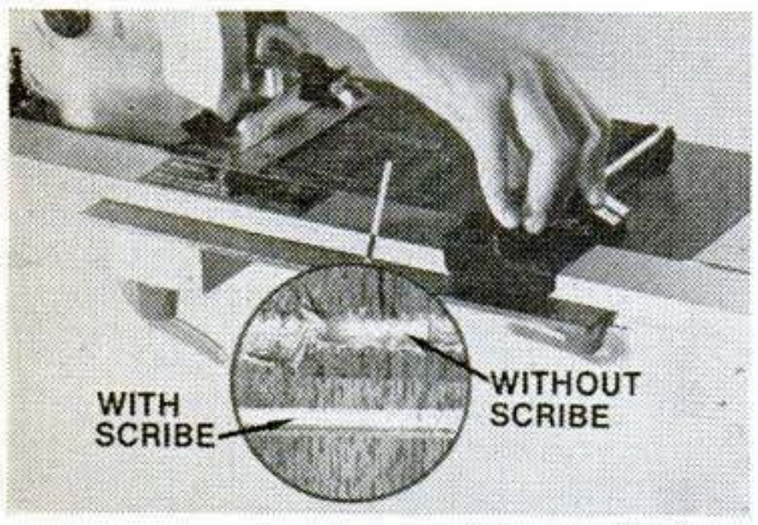

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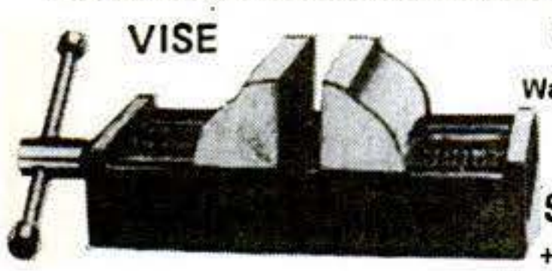

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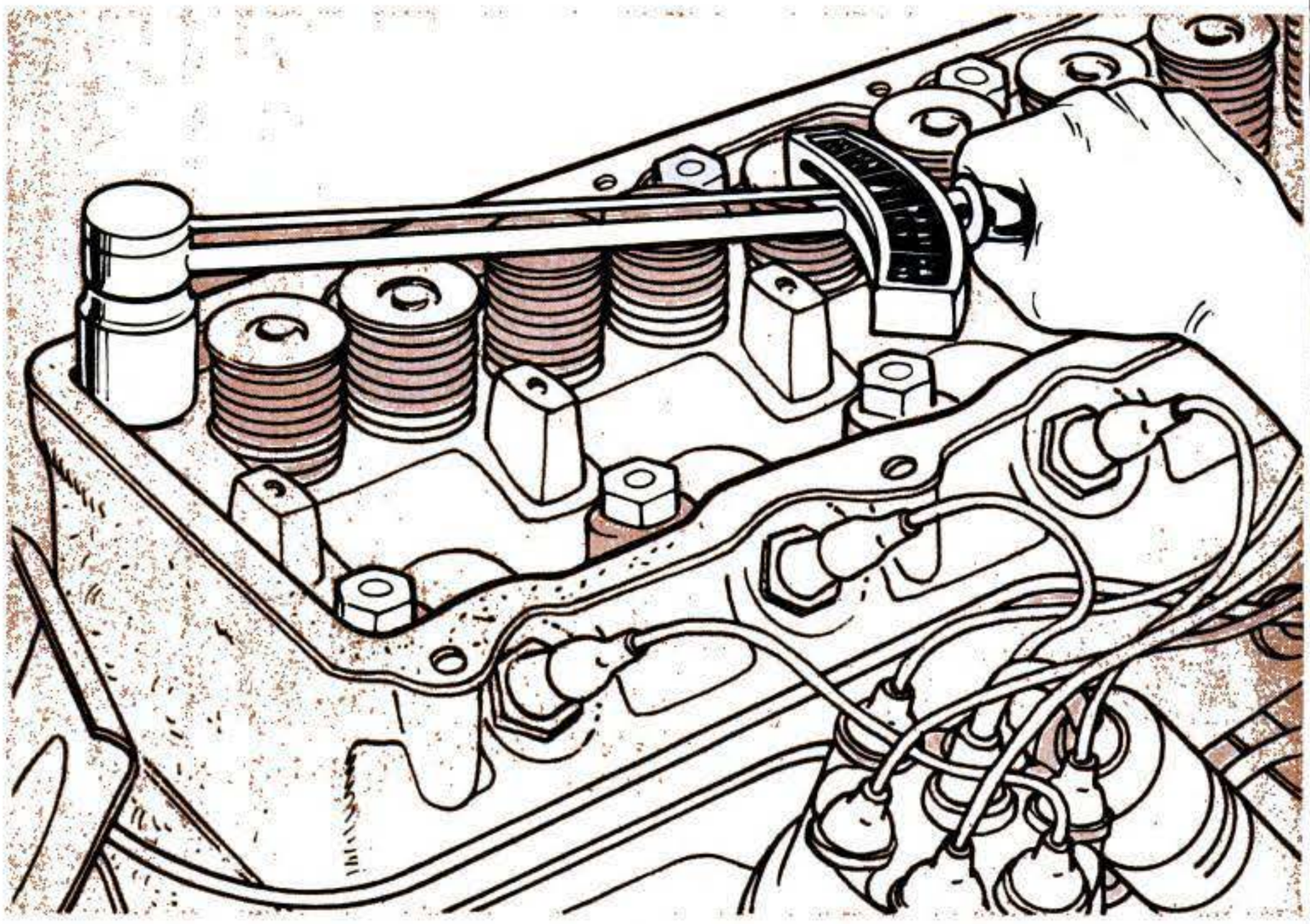
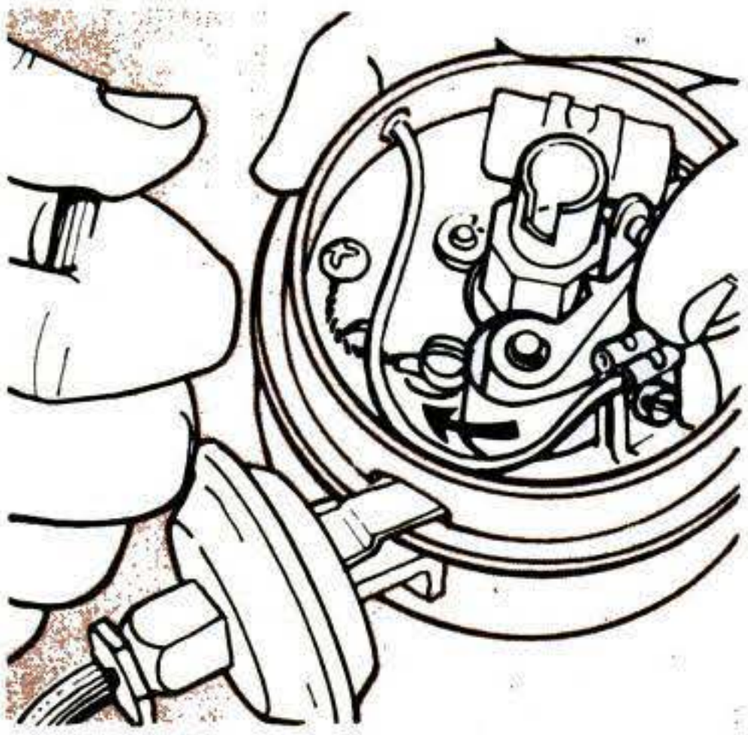
By RICH CEPPOS

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



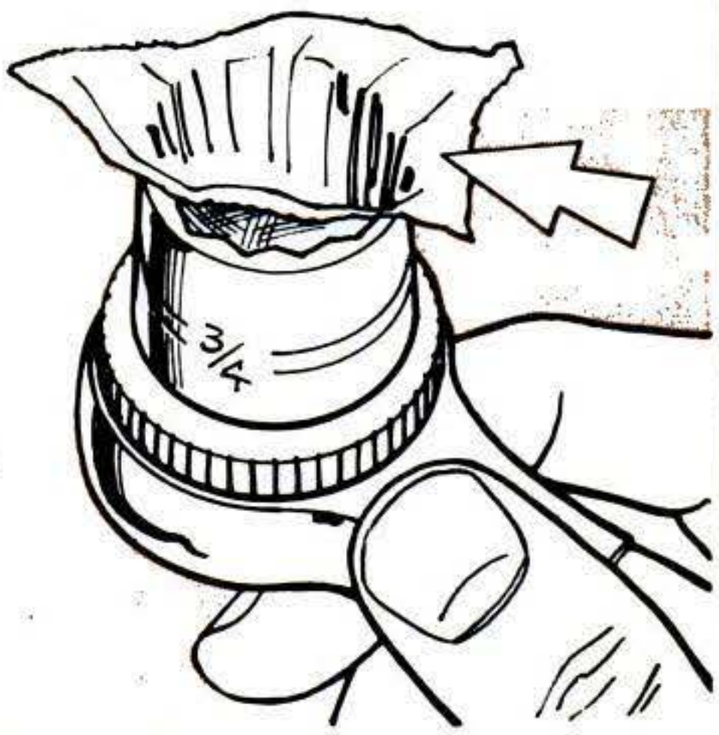
Retightening a newly installed cylinder head

After installing a cylinder head, be sure to re-torque it at the recommended interval. Otherwise you run the risk of losing head-to-block sealing if the cylinder head loosens. Oil could mix with coolant, causing a loss of lubrication, which will ruin rod and crankshaft bearings, and other internal reciprocating parts. Tighten the head bolts in the specified sequence in two or three stages. When you bring them up to specified torque, do it in one smooth, steady motion to avoid incorrect readings due to bolthead adhesion.



Checking vacuum advance

If you suspect your distributor's mechanism is not working properly, check it this way: Remove the distributor cap and rotor, and the vacuum hose to the advance diaphragm at the carburetor side. Rotate the breaker plate as far as it will go with one hand and seal off the vacuum hose with your other thumb. Now let go of the breaker plate. If it moves before you remove your thumb from the vacuum line, the advance diaphragm is leaking.



Loosening odd bolts

If you're trying to loosen a stuck American bolt with a metric socket, or vice versa, stuff a small square of paper toweling or a thin rag into the socket next largest to the bolt. This fills the gap between socket and bolt, and gives the wrench a better grip, which keeps it from slipping and rounding off the bolt's head. This method can also be effectively used with box-end wrenches.

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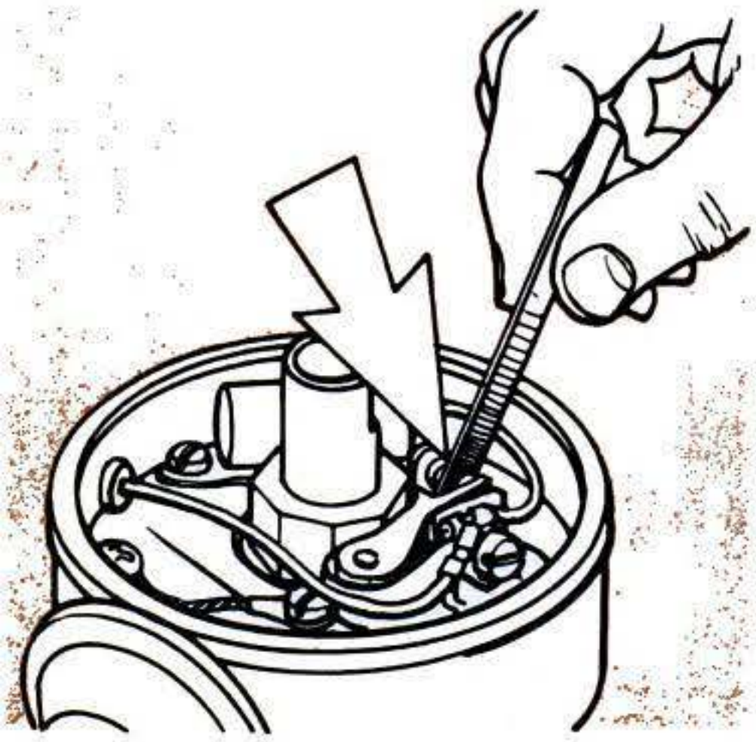
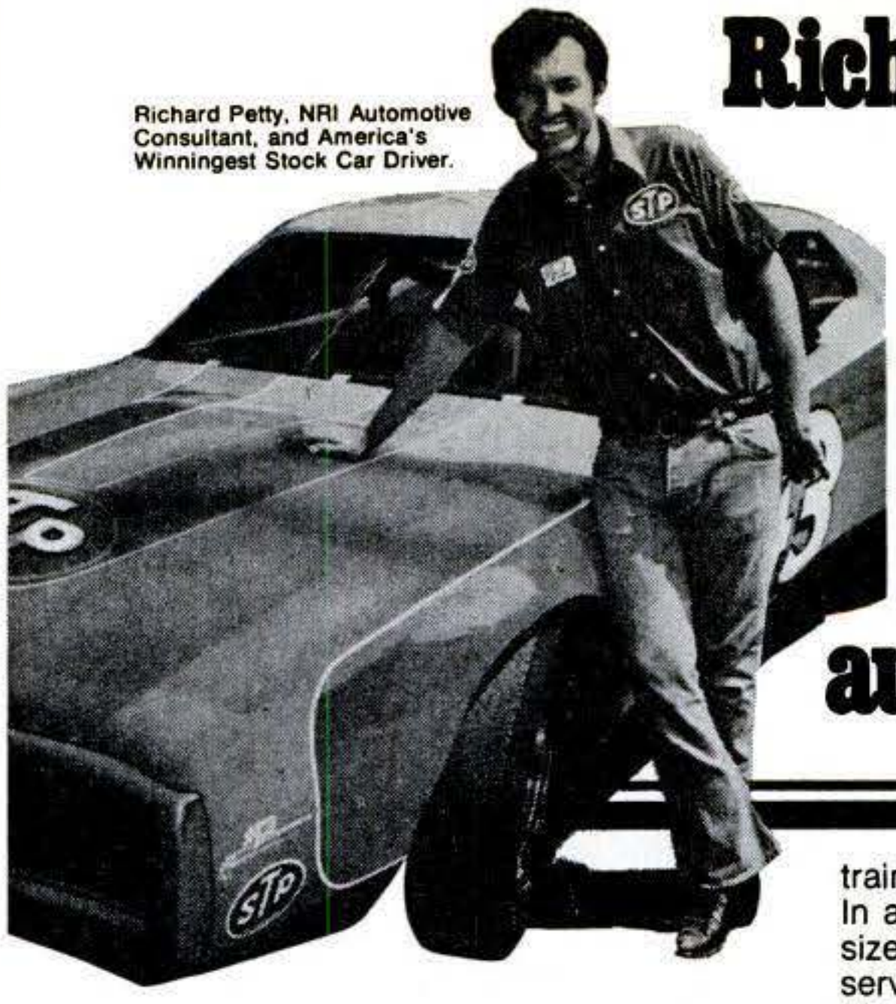
Making timing easier

If you're having a hard time seeing the timing marks on the cylinder block or the timing notch on the crankshaft pulley, put a dot of fluorescent paint on the marks you wish to stand out. Aim the timing light like a rifle, sighting the marks down the "barrel" of the light.



Setting point gap

When you're setting ignition contact-point gap with a feeler gauge, "feel" is all-important in judging the right gap. To improve your feel when using a multi-blade feeler gauge, remove the proper blade from the pack and grip it gently between your thumb and forefinger as you run it back and forth between the points. Then clean the points by sliding a clean piece of paper or a business card through them. PS



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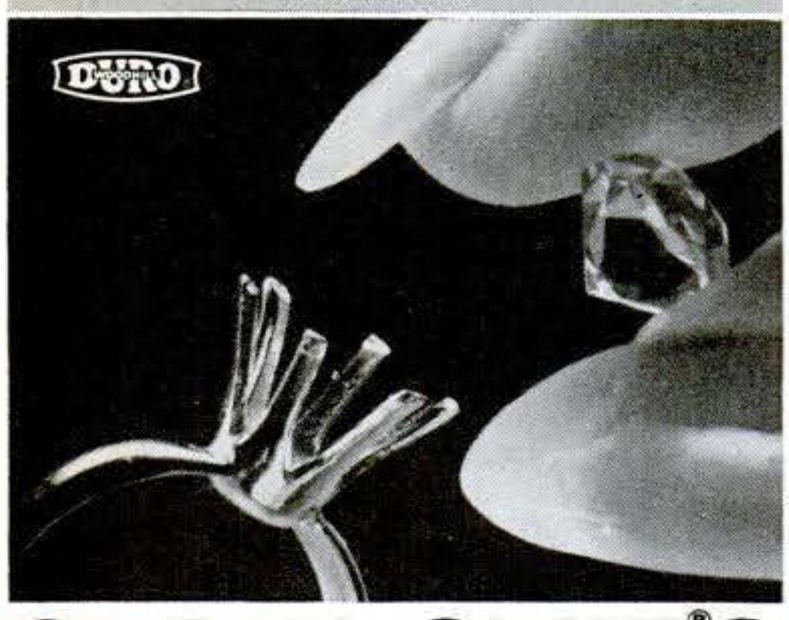

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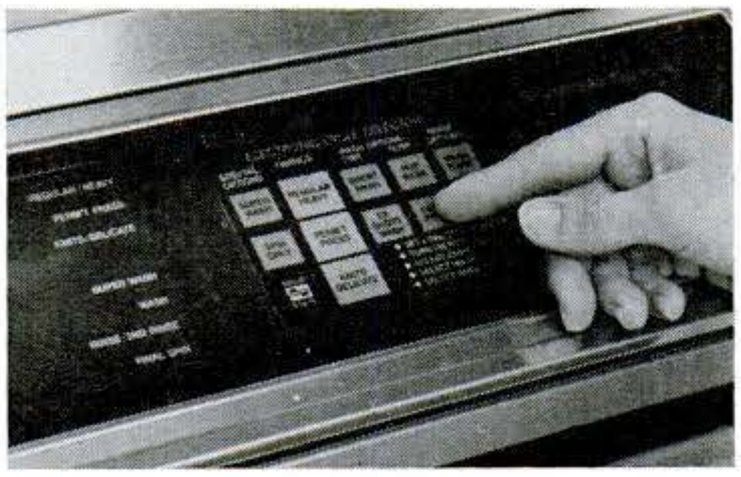
HOUSEPOWER CLINIC

By EVAN POWELL

Space-age home appliances

Some of my comments during the past year may have suggested to you my disappointment at the lack of innovation in home appliances, from a standpoint of both new features and energy savings. Now, however, it looks as though some good things are in store for next year.

Already on the market are electronic controls for washers and dryers by Whirlpool (photo below), and for washers, dryers, and dishwashers by Sears. The electronic controls are all based on microprocessors, which offer both versatility and reliability. They are becoming so widespread that consumers need to know more about them.



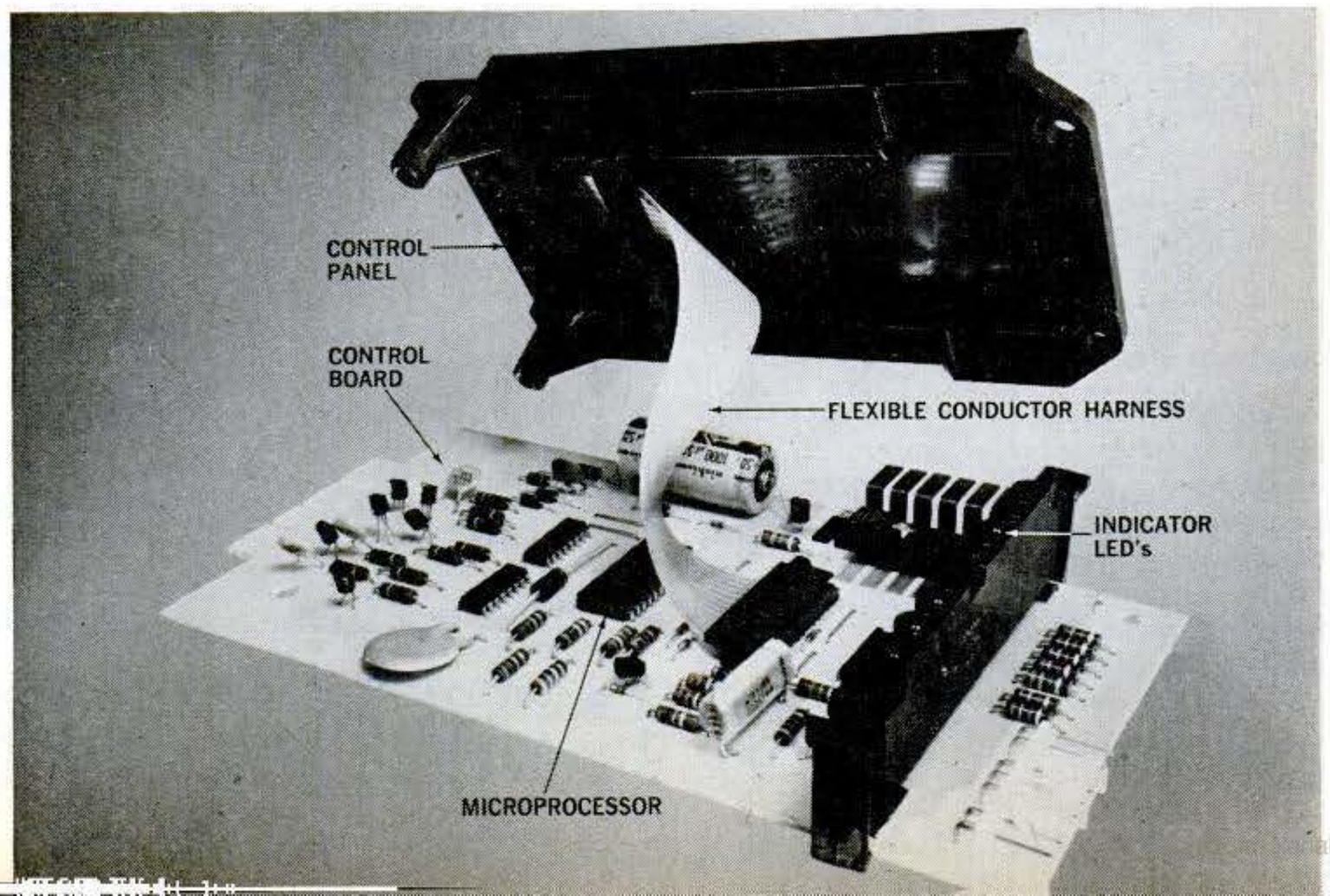
A microprocessor is a type of integrated circuit (IC)—a device that combines interconnected electronic parts on a single chip, usually silicon. Thousands of transistors and associated parts can be combined on one IC. A microprocessor is programmable. It takes inputs from timing, control, and sensor circuits, and produces a number of output functions sequentially to control a process.

These brainy chips are well-proven. Today's calculators, watches, and many microwave ovens use microprocessors [PS, March]. Singer has an electronic sewing machine with a memory—thanks to a microprocessor. And the electronic tuners on many television sets are microprocessor-based.

As an example of what microprocessors can do, consider one of the first "push-button" automatic washers from 1959: Depressing one of the cycle-selection buttons started a rapid-advance motor that twirled a hidden timer. Connected to this was a sweep arm with contact surfaces that wiped across a section of printed-circuit board. When these contacts reached a point that completed a circuit set up by the push button, the rapid-advance motor turned off and the timer was in the correct position to begin the washing cycle.

This system worked, but all it really did was allow you to push a button rather than turn a knob to set the particular cycle. It was bulky, and in an environment of moisture and inevitable chemical spills from bleach and detergent, it wasn't noted for endurance. There were contact surfaces on printed-circuit boards and many additional gears and ratchets that service technicians had to contend with, and there was still the mechanical timer with all of its cams and contacts. Timer failures constitute a major portion of appliance problems, both in frequency and expense.

Contrast this with the microprocessor control on the new washers, which is contained on a single small board, has no moving parts, and offers much more versatility. The photo below gives you an idea of the workings of a micropro-



ssor in appliance control. When you uch the selector panel, you are actuat- g an input device to feed the cycle sired into the microprocessor. Your lection of cycle, plus any other op- ons, is then stored in a "random-access emory" (RAM) section until needed until a new cycle is selected. Based on these temporary cycle instructions the RAM, the microprocessor then eads" a "read-only memory" (ROM), hich stores the *permanent* operating structions. At this point the micro- ocessor signals the appliance's elec- omagnetic functions (motors, sole- ids, etc.) to begin an operation in a edetermined sequence for specific nes. This part of the sequence is much e that served by the old mechanical ner, but there are no moving parts or ntacts to give trouble. Also, the mi- oprocessor monitors operations and n react to certain situations (such as overfill condition in a dishwasher) to minate the problem. Output from the croprocessor also energizes light- nitting diodes (LED's) or lamps to in- cate the cycle's progress.

While the present use of microproces- rs in home-appliance controls is a fine provement, it's by no means the ulti- ate application—as you know if you ad PS's October cover story on home mputers.

efrigerators and cold rooms

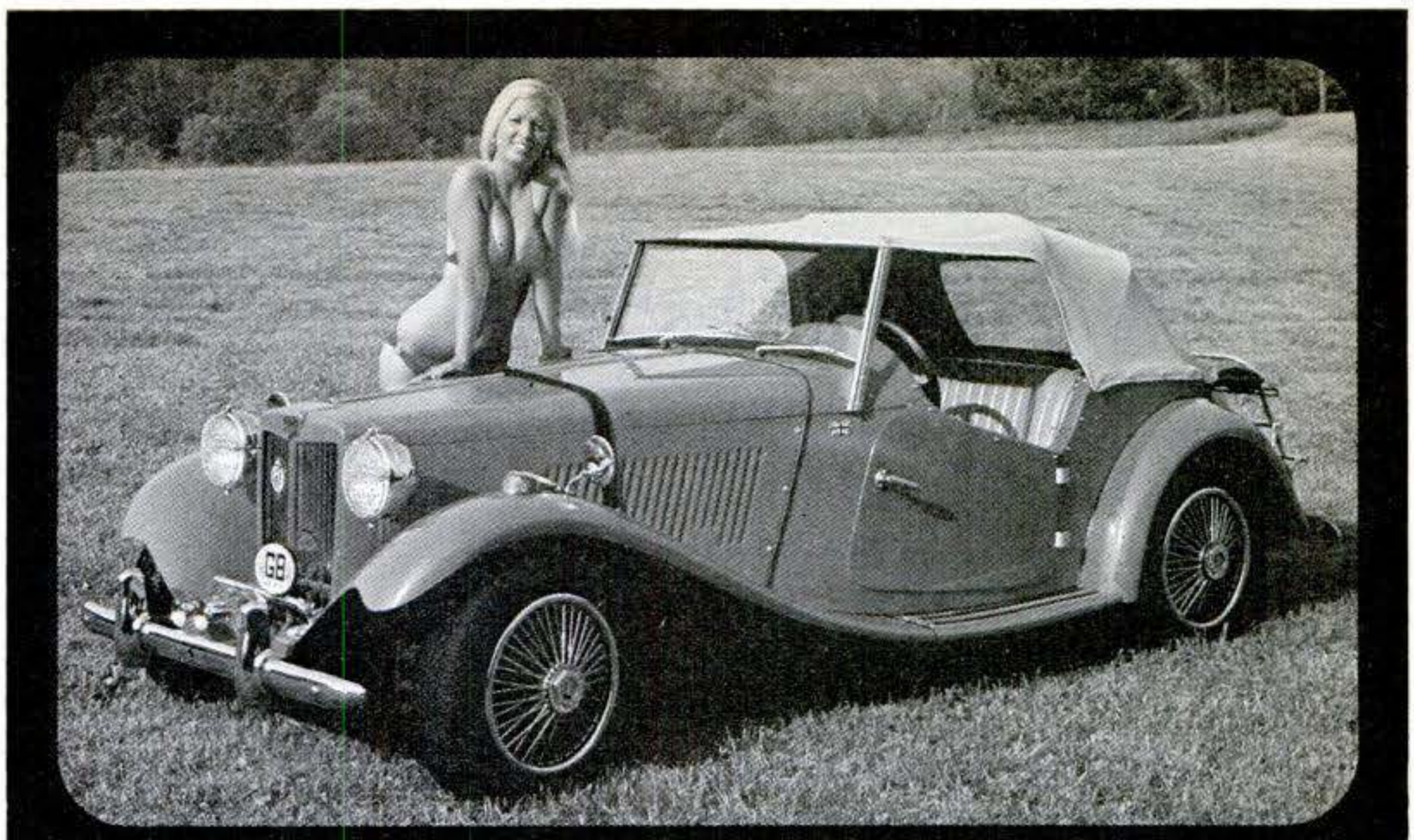
ou might think that your refrigerator ould thrive in a cold room, but that's t always true. Refrigerators are made operate in normal room temperatures, d if you keep one in an unheated ace, such as an enclosed porch, funny ings can happen.

Most units today have dual controls ne for freezer, one for refrigerator), hough the control may be simply a ffle that adjusts the amount of air- w between compartments. With room mperatures of 55 degrees or below, ort-cycling can occur, with a resulting e in freezer temperatures. Or, with ner control systems, freezing may oc- r in the refrigerator section.

If you encounter one of these prob- ms, try this: If the freezer is too warm, rn the freezer control one increment gher, leave it for 24 hours, then re- eck. Keep adjusting until the tempera- e is near zero. If your symptom is ezing in the fresh-food compartment, rn the refrigerator control one incre- ent lower. If it's as low as it will go, rn the freezer control one setting rmer. Of course, you'll have to re- just next spring. PS

Got a problem?

Space didn't permit any questions nd answers this month, but a good it of this column is usually de- oted to solving readers' home-equip- nent problems. Send yours to Evan Powell, Housepower, 108 Morning- lale Drive, Greenville, S.C. 29609, iving make and model number of equipment. Sorry, but questions can't e answered by mail.



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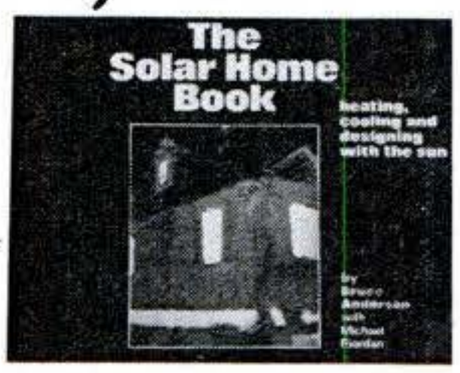

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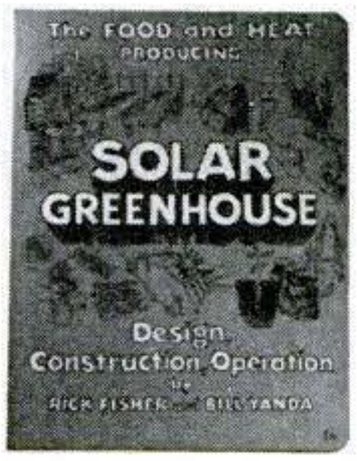

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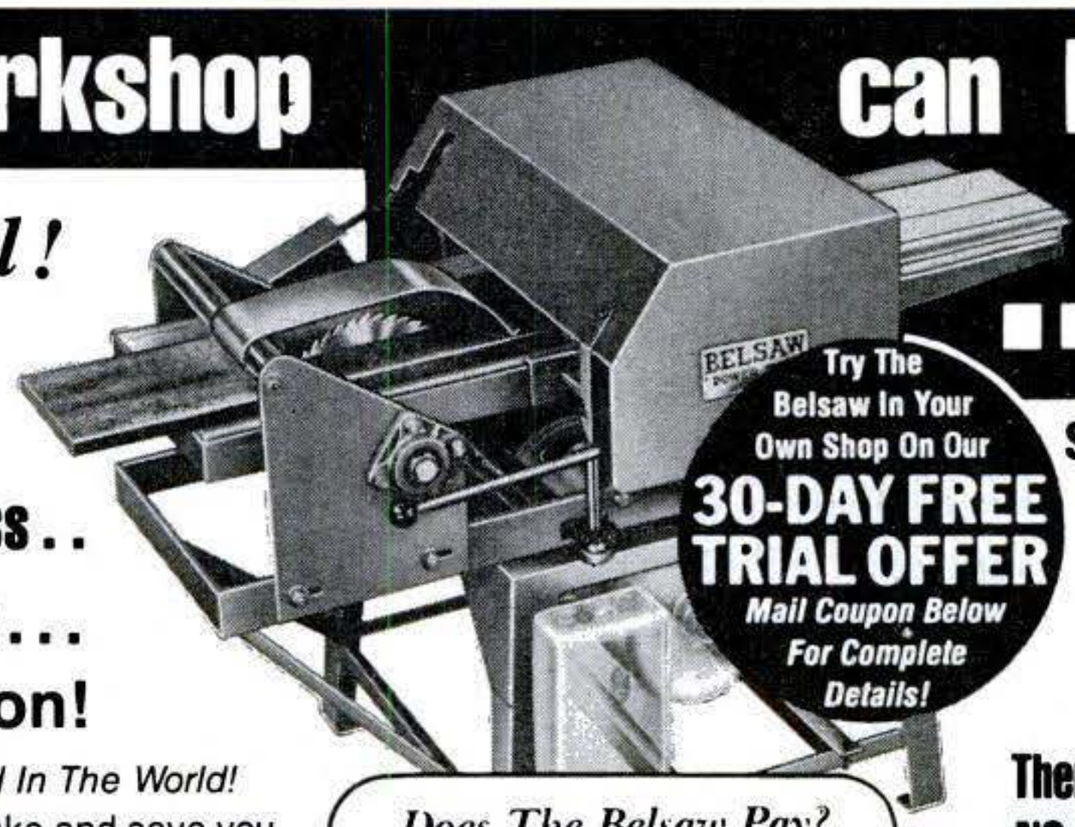

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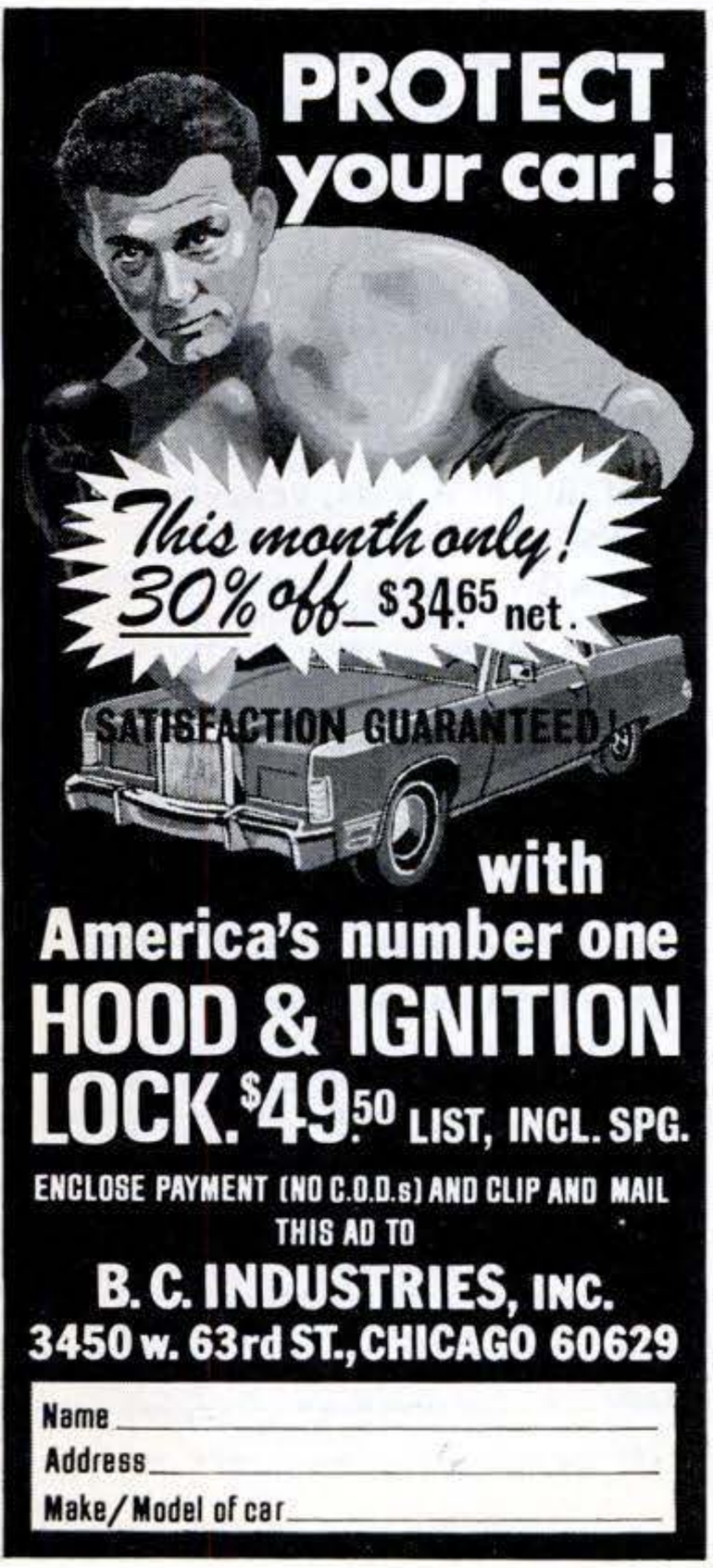

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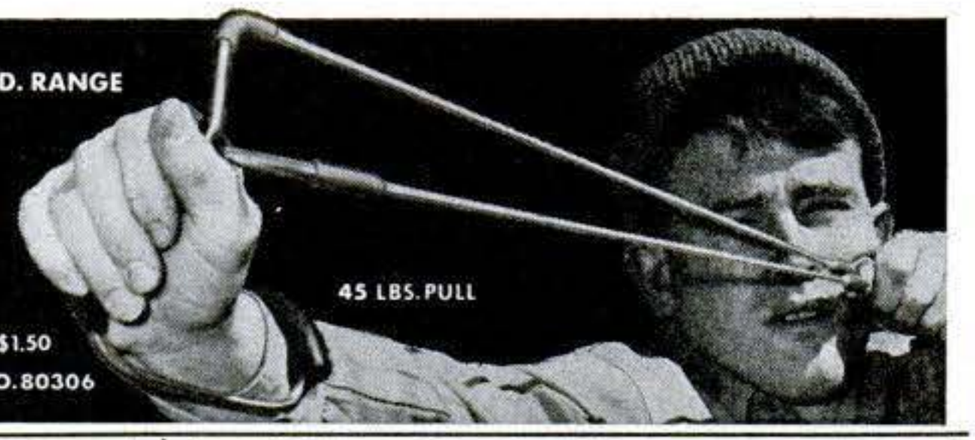

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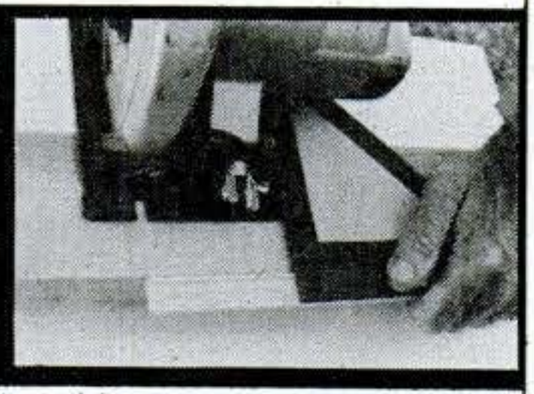

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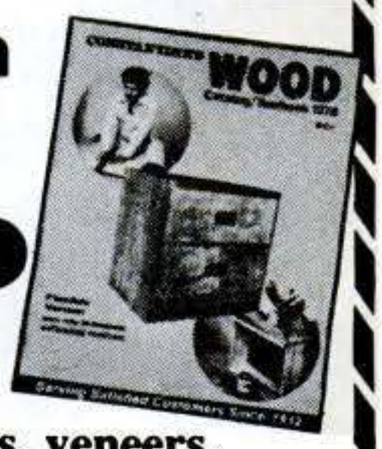

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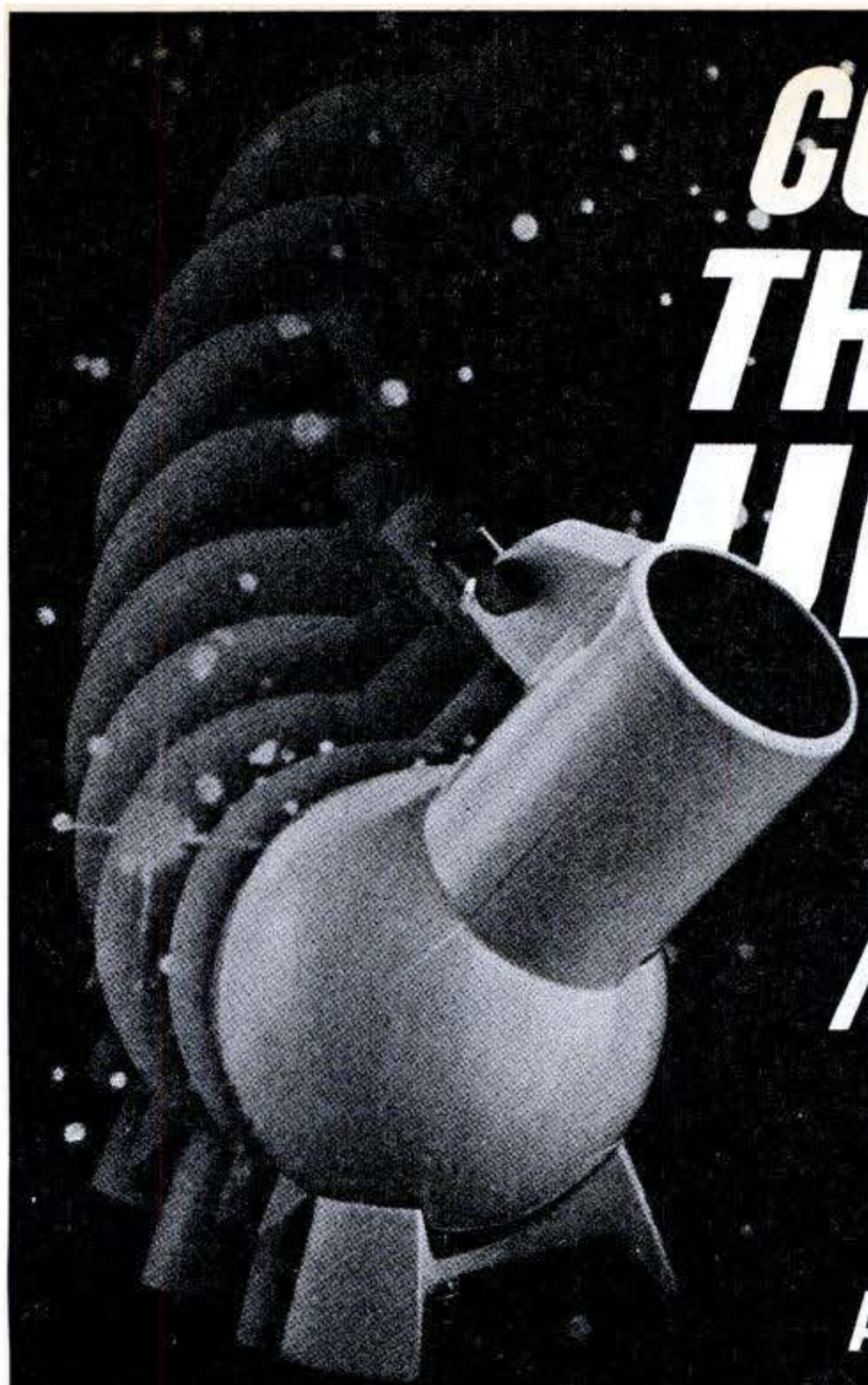

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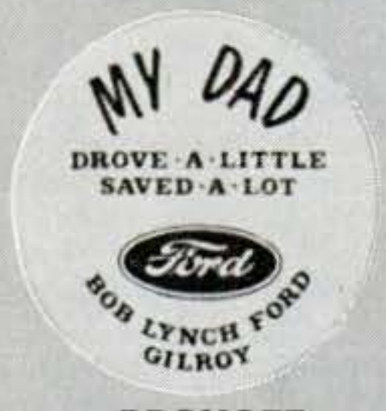

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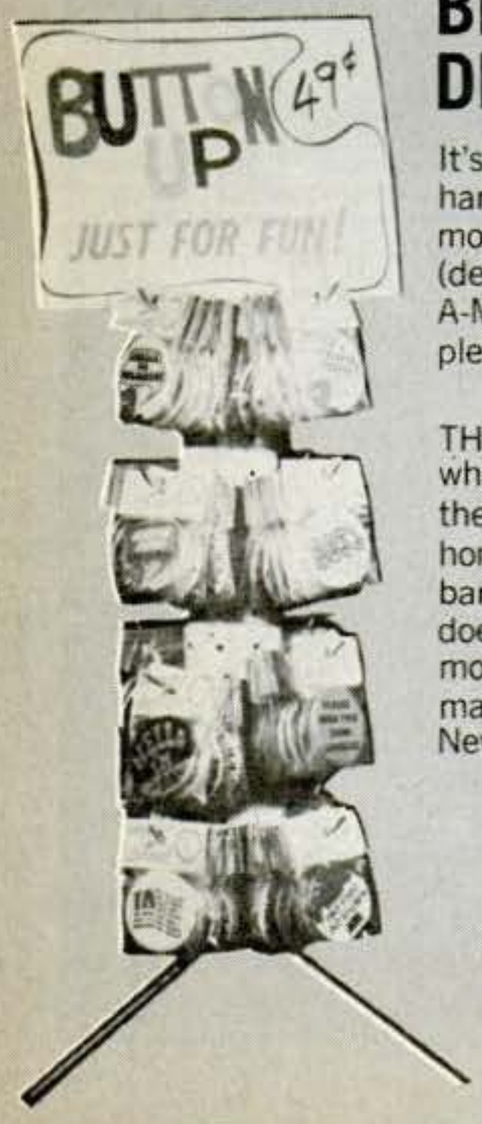

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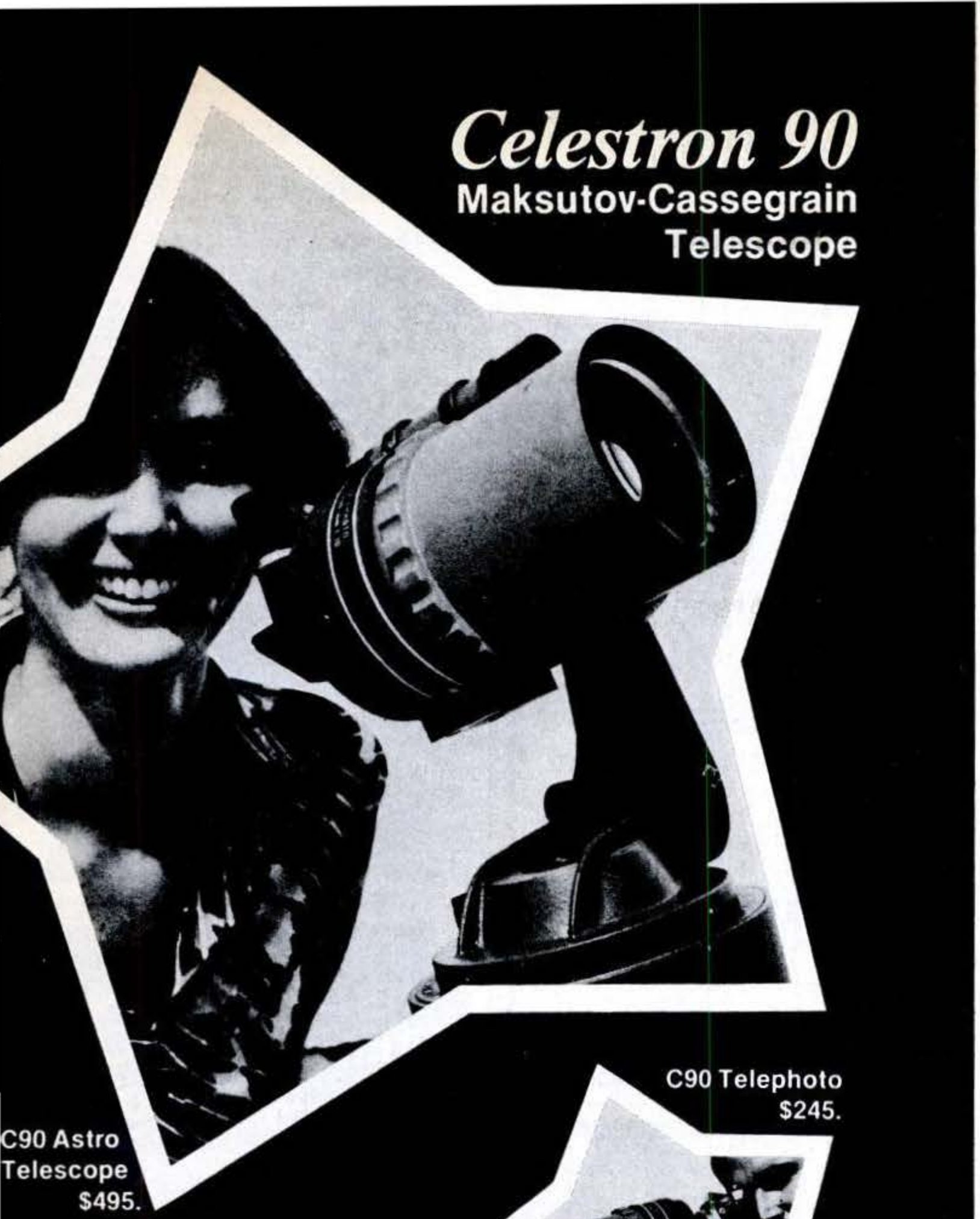

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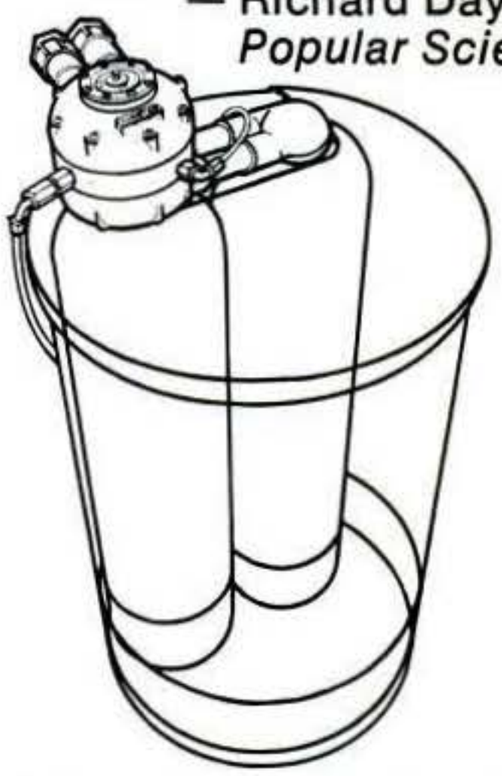

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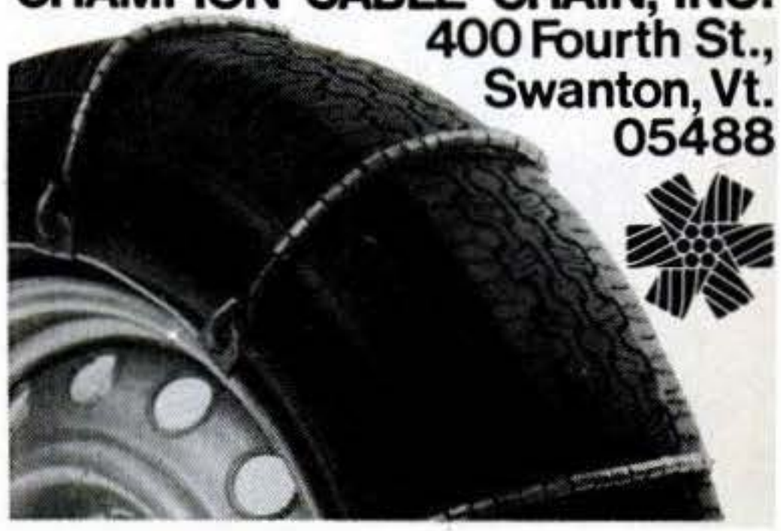

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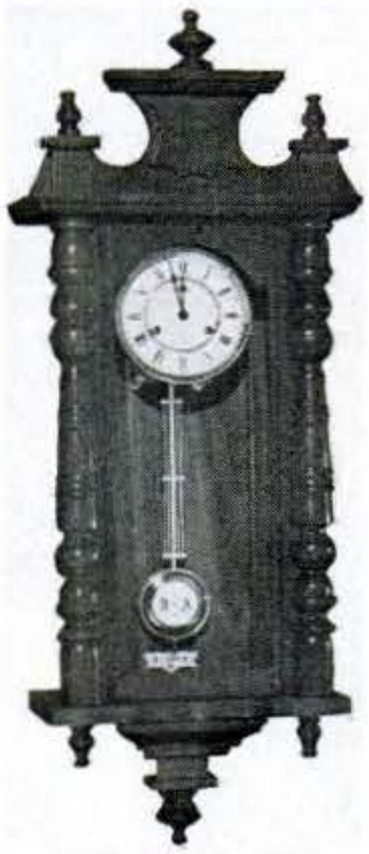

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The special LIFESCREEN, Lens and Front Surface mirror supplied by Extron are the same type used by major Big Screen TV manufacturers (Sony, Muntz, etc.). THESE PROFESSIONAL COMPONENTS SHOULD NOT BE CONFUSED WITH THE CHEAP PLASTIC MAGNIFYING IMITATIONS NOW FLOODING THE MARKET BECAUSE OF THE POPULARITY OF BIG SCREEN TV.

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EXTRON LS 50 Screen, 32"x40"/50" Diag.

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1 LIFESCREEN Lens
1 LIFESCREEN Front Surface Mirror, 8" x 10"
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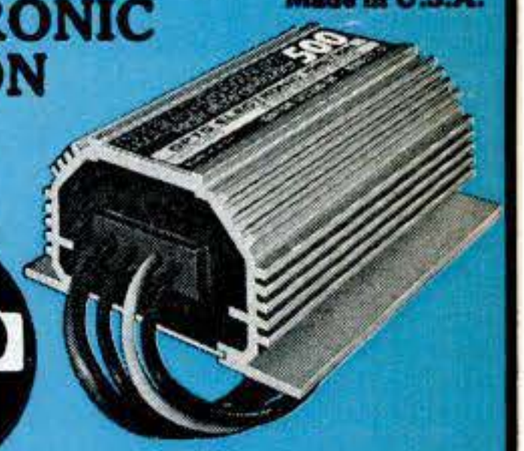

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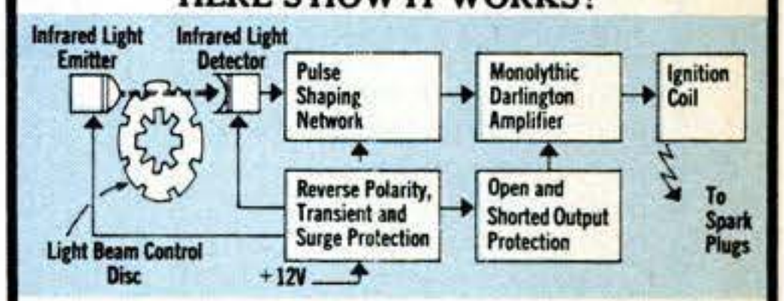

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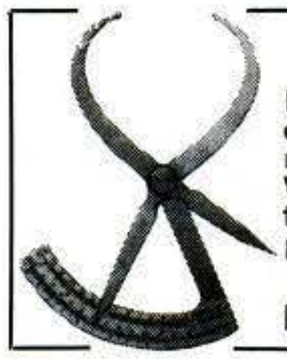

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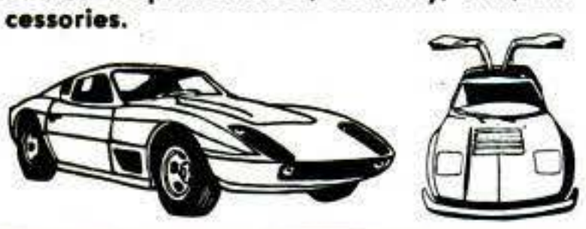

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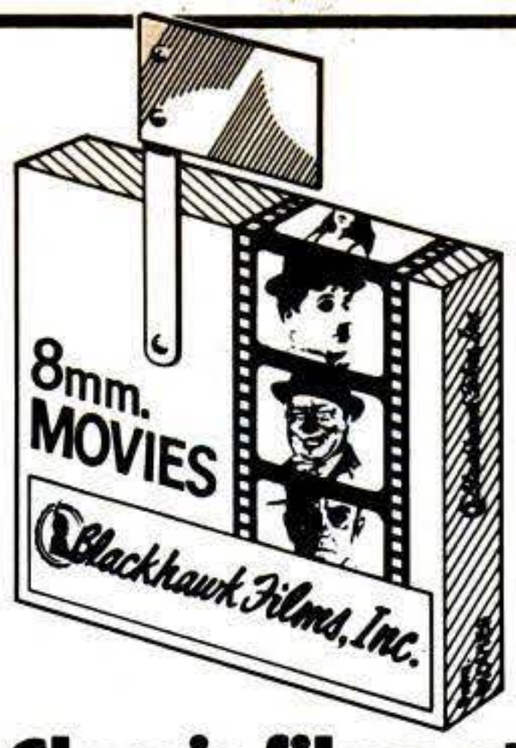

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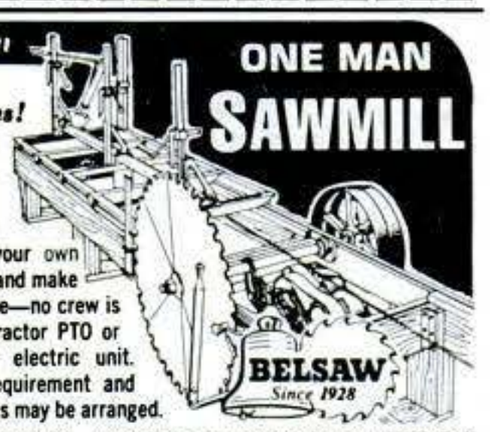

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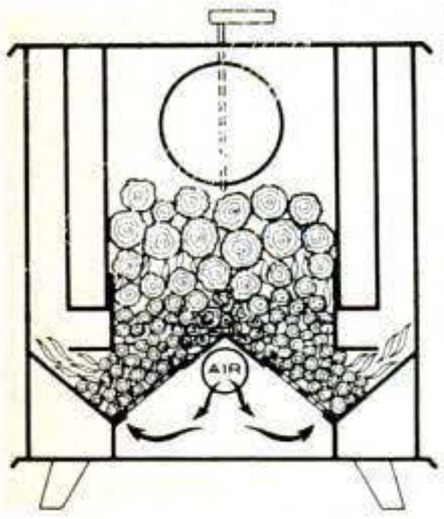

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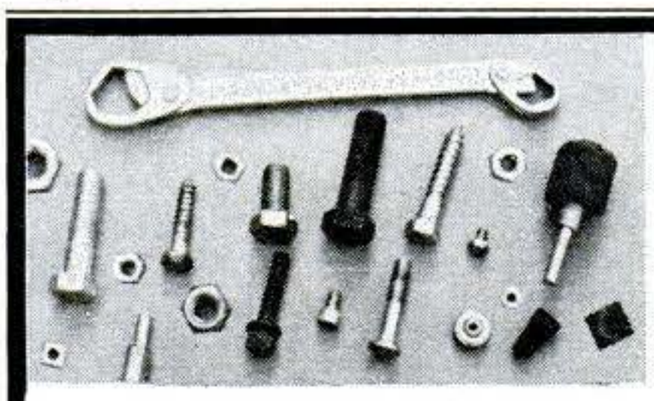

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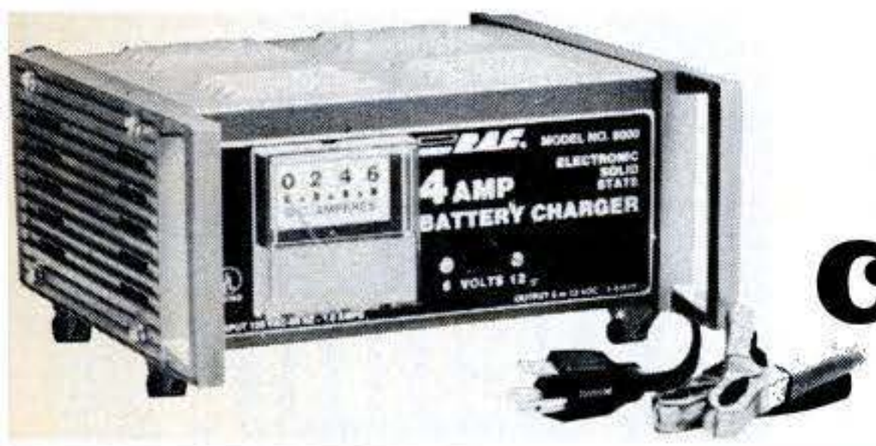

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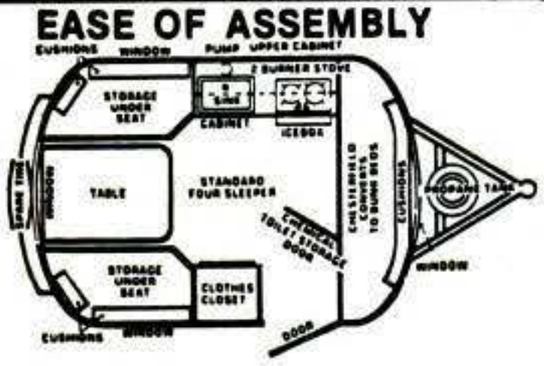

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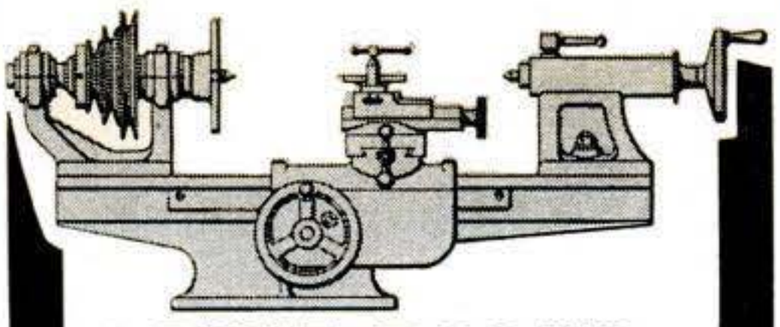

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Compact Utility

In less space than required to store a bicycle are the five most important tools for a workshop. A 10" table saw, 12" disc sander, horizontal boring machine, 16½" vertical drill press, and 34" lathe.

Unique Design Concept

Shopsmith overcomes the standard reputation that anything multiuse tries to do too much and ends up doing nothing well. It is the only tool designed specifically for multi-use. In a single tool there is the complete compatibility and non-duplication of the four basic parts that make up every stationary power tool: 1) a *motor* 2) a *spindle* 3) a *table* (tool rest in the lathe) 4) and *bench*.

By attaching various tools (saw blades, drill bits, etc.) to the spindle and changing the relationship of the operating tool to the table, Shopsmith performs each tool operation in the conventional tool manner.

Simple to Use

Included with every machine is a well illustrated book that takes you step-by-step through the tool changeovers. After a few hours of practice you'll be making changeovers in less than 60 seconds.

Please don't be confused. Some critic's objection that you're "always changing over" simply isn't so! Woodworking isn't done by hopping from one tool to another, you plan your projects so you do your sawing, then drilling, etc.

Shopsmith owner Fred Wescott of North Scituate, Mass. sums it up best when he wrote us as follows: "I've heard objections about frequent lengthy changeovers from people who *do not* own Shopsmith, but I've never heard it from a Shopsmith owner."

The Right Power - The Right Speed

The Shopsmith Mark V is equipped with a 1-1/8 h.p. commercially rated motor. It's 13.5 amp and uses standard 110 volt household current.

Different tools and operations require different speeds. The Shopsmith exclusive speed dial allows for speed adjustment, while motor is running, from 700 to 5200 RPM. No belts or pulleys to change like individual tools.

Accuracy Built-In

No matter who flips the switch—experienced craftsman or beginner, the Mark V will do the same for both. Precision positive stops, ability for micro-adjustments, and convenient ready-to-use jigs make it possible.

It's Costly To Duplicate

Compare Shopsmith feature to feature and capacity to capacity to individual power tools. You're in for a real surprise! To duplicate the features and capacities of the Mark V in individual tools, would require buying commercial tools at three times the cost of a Mark V. Many features can't be duplicated at any price!

Of course you could purchase a table saw, sander, drill press, and lathe at less than commercial prices. But, even then, the table saw and drill press would cost as much or more than a Mark V.

Project Savings Justify

Over the years the Mark V will pay for itself many times over. No matter how small or big your project is, your Mark V and you can do it for less than hiring it done or buying it. From making a bird house to building a grandfather clock, you'll save by doing-it-yourself.

Commercial Uses

The versatility and accuracy plus the space saving feature of the Mark V make it the ideal tool for maintenance departments of hospitals, schools, industrial plants, apartment complexes, or anywhere a woodworking shop must be set up in limited space and on a limited budget.

Shopsmith Mark V's are used in schools to teach woodworking and in hobby shops of military bases or condominium complexes. Wherever there is a need for a woodworking tool, you'll find the Mark V.

The Best Tool For You

We know the Mark V is the best tool for you. But, only you can decide that. Over 300,000 other woodworkers have made the decision to own Shopsmith woodworking tools and have not regretted it.

Before you purchase a power tool or add another to your shop, you should determine for yourself whether Shopsmith is the best tool(s) for you. Send for informative brochure today.

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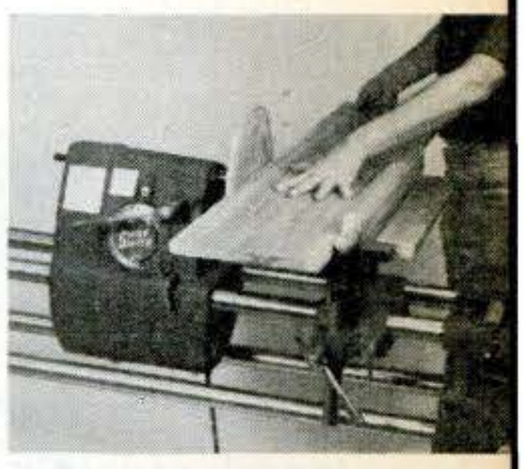
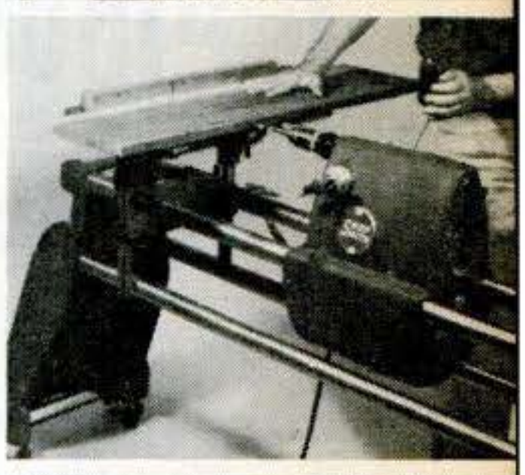
The Mark V as a 10" table saw, gives a 3¼" depth of cut with a 48" rip capacity. Exclusive Speed Dial permits power sawing of hardwoods. Use your Mark V for ripping, cross-cutting, mitering, beveling, molding, tenoning, grooving, rabbeting and dadoing.

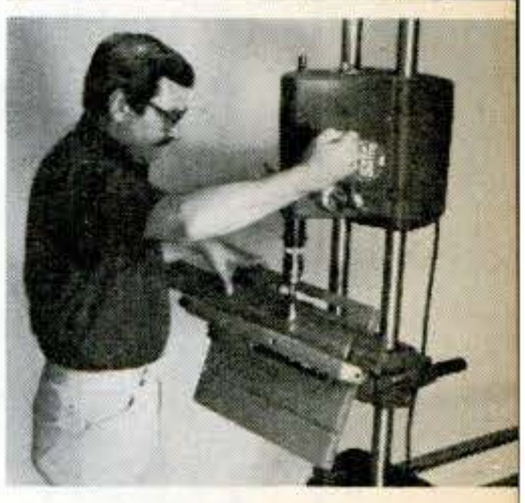


The Mark V as a 12" disc sander gives you operations not possible on other sanders. Like finishing edges to precise dimensions. It's actually a jointing operation and is done by setting the rip fence at a slight angle to the disc. Sanding duplicate pieces to exact lengths is another Mark V exclusive.

The Mark V as a lathe offers exceptional capacity with a 16½" swing for faceplate turning. Exclusive Speed Dial allows a speed range of 700 to 5200 rpm. Use your SHOPSMITH Mark V for spindle turning, faceplate turning, concentric drilling, taper turning, and metal spinning.



The Mark V as a horizontal boring machine permits perfect dowelling. Material is laid flat on large 14" x 18-3/8" table and backed up by rip fence. Exclusive feed stop assures all holes will be exactly the same depth. Lock the table at a specific height for perfect alignment of holes at same level. Unlimited capacity for mortising and concentric drilling.



The Mark V as a 16½" vertical drill press can be setup to drill perfect screw pockets. The rip fence and tilting table form a V-block for holding material. Time is saved on every drilling operation because the Mark V has depth control dial, ready made jigs, and the right speed for every operation without belt changes. Use your Mark V for drilling, mortising, routing, shaping, metal drilling, reaming.

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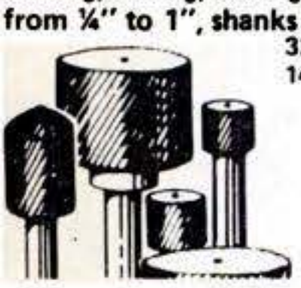

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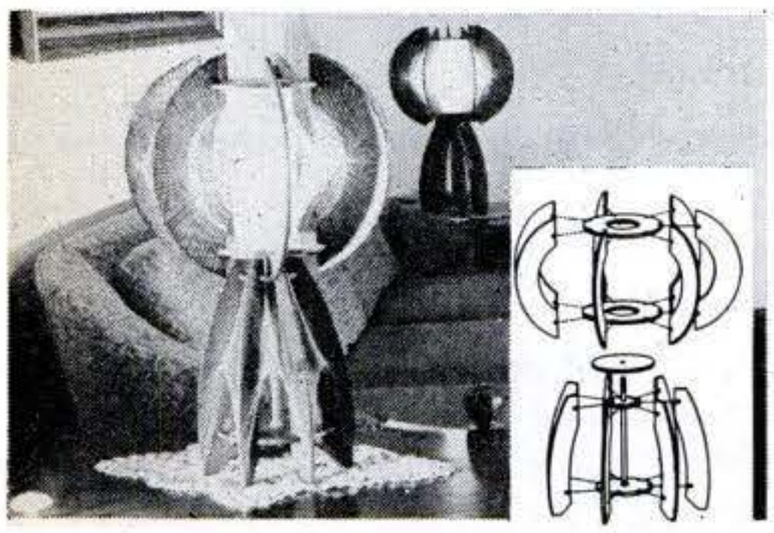

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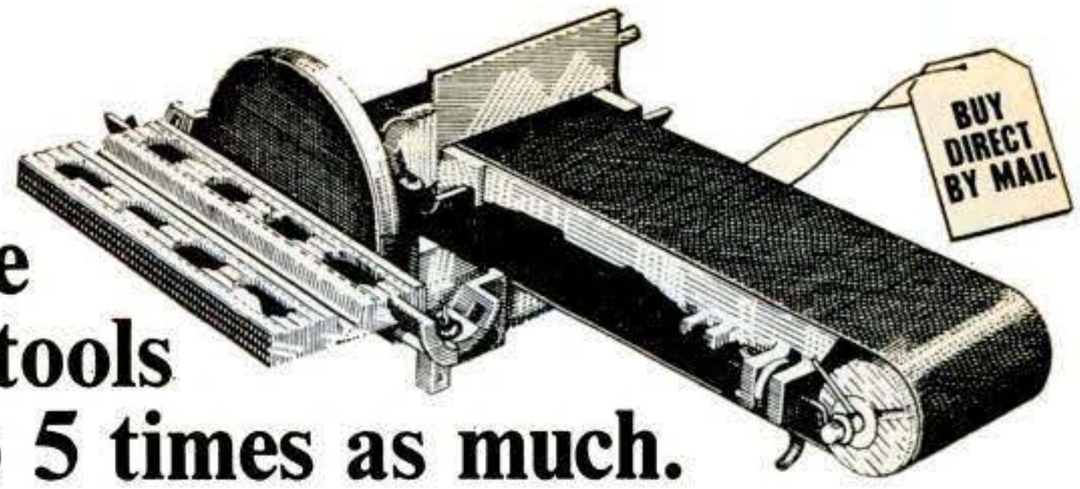

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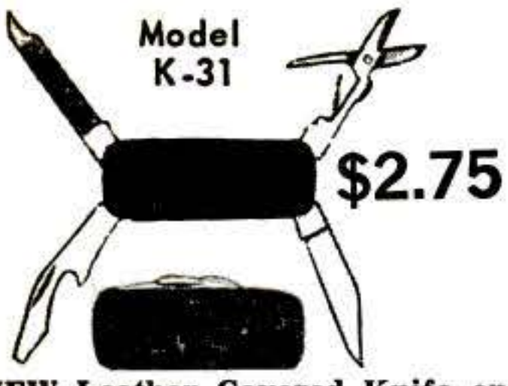

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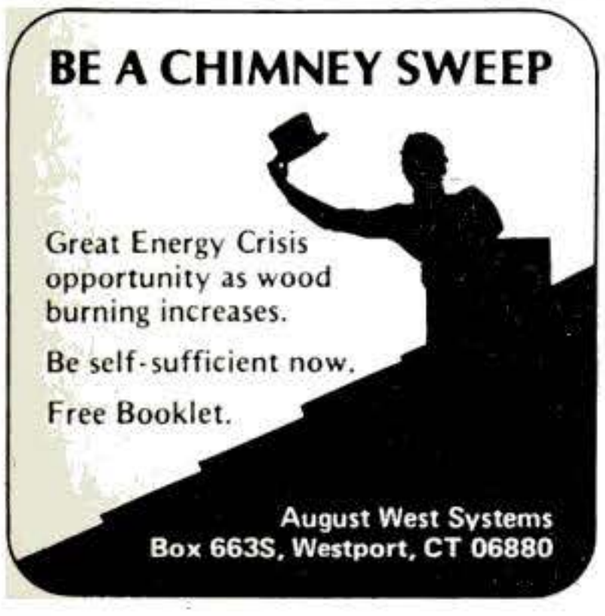

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Sure, you've seen plenty of sale prices . . . from $79 on up . . . on "sissy" little chain saws. And they're adequate for trimming twigs and branches off your backyard trees. But when you want to tackle the BIG trees in the forest for a winter supply of firewood, little "toys" can't take it. You need a chain saw with plenty of guts, plenty of cutting bar, and big, strong "teeth" to make short work of large trees. You need this Pioneer 650 Workhorse!

This is the same great model used by commercial loggers for their daily living! They KNOW it takes a powerful PIONEER to rip through huge trees, day after day, without binding or burning out. This PIONEER's maximum 6000 r.p.m. with chain speed of 2800 ft./min. does any big job, faster and easier!

Now you can get the same chain saw the "pros" use . . . at a HUGE SAVINGS! OMC closed their PIONEER chain saw division. Now we must liquidate this entire inventory of Model 650 chain saws at FAR BELOW DEALER'S WHOLESALE COST! It's a fantastic opportunity to buy a powerful, commercial logging saw at not much more than those little backyard models. But don't delay. Quantities are limited. Mail your order today!

Regular Retail $539.00

LIQUIDATION PRICE NOW ONLY:

$166

With 20" cutting bar. (Add $10 more for 24" cutting bar.)

F.O.B. your door. No tax. No shipping charge. Includes one extra FREE chain. QUANTITY DISCOUNT to municipalities, utilities, logging firms, govt. agencies.

For Mastercharge or BankAmericard (VISA) only:

Phone in your order on our toll-free number: **800-328-5082** and charge it.

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C.O.M.B. Co. *Authorized Liquidators*
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Please send _____ Pioneer Model 650 commercial logging chain saws.

☐ With **20-inch** cutting bar @ **$166.00** each, with one extra FREE chain each

☐ With **24-inch** cutting bar @ **$176.00** each, with one extra FREE chain each

My check or money order is enclosed. There is no tax, no shipping charge.

PLEASE PRINT CLEARLY

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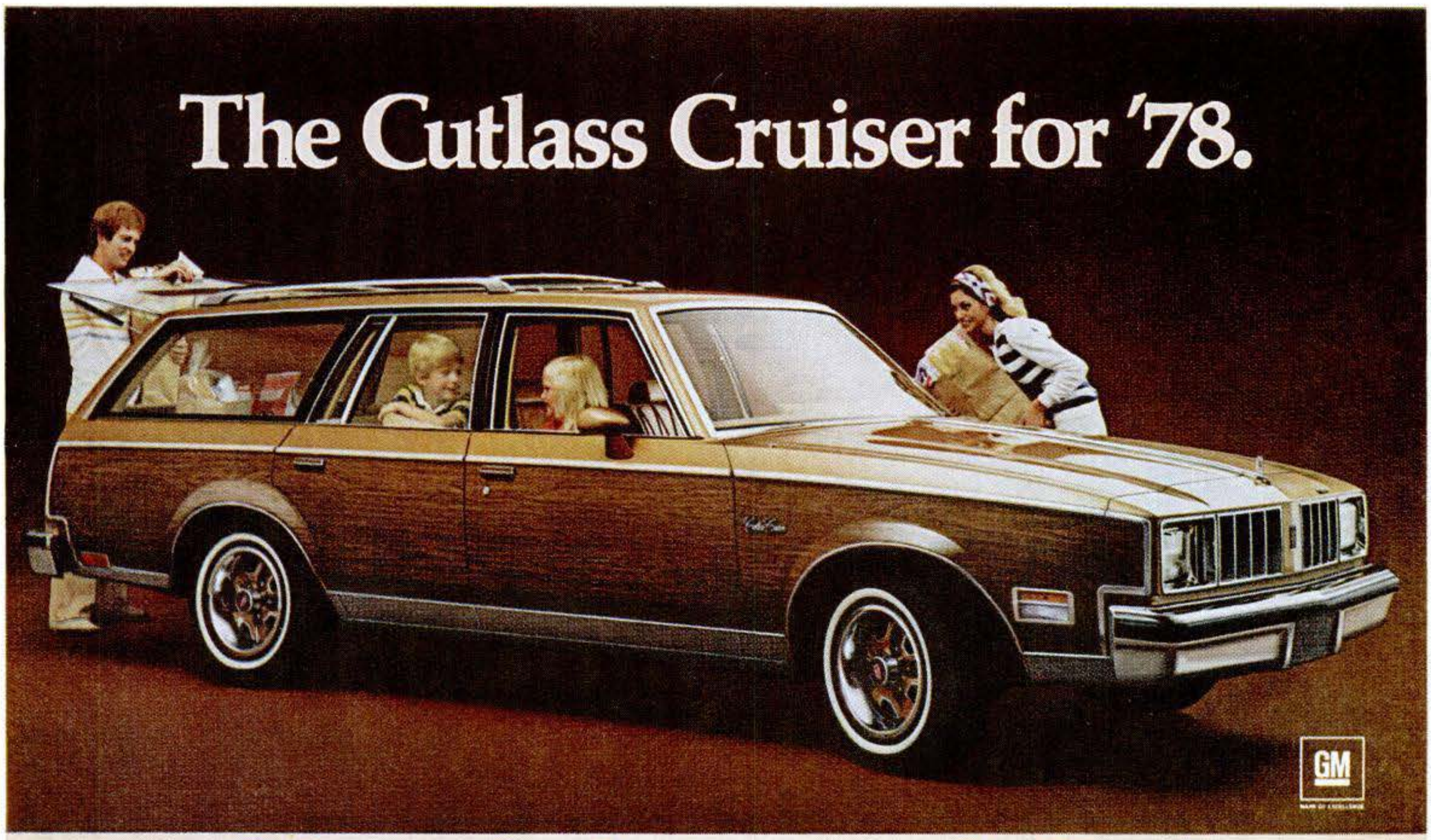
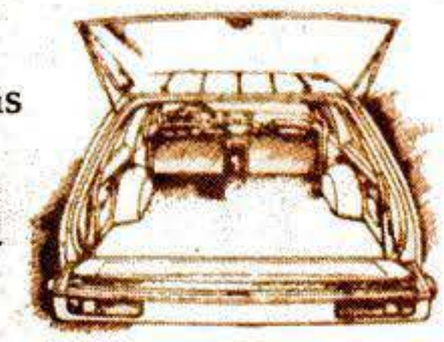
The Cutlass Cruiser for '78.



It's a whole wagonfull of good ideas.

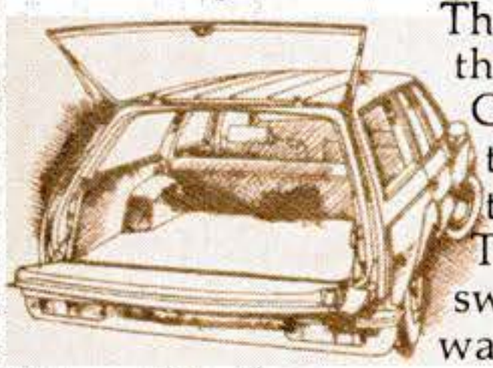
One Big Idea.

"Design a wagon that's as beautiful and comfortable as a Cutlass, but as roomy and functional as a new mid-size wagon should be."



That's no ordinary assignment. So the new Cutlass Cruiser turned out to be no ordinary wagon. It looks like a Cutlass, rides much like a Cutlass Sedan, loads and carries like a wagon —it adds up to one big beautiful idea.

Two Easy-Loading Ideas.



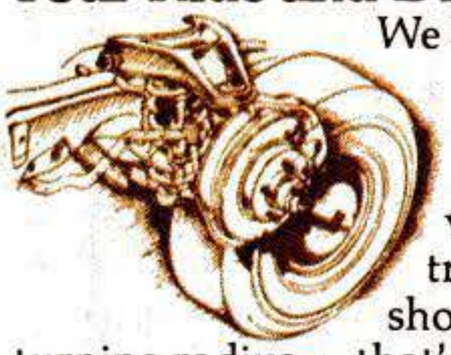
This year the Cutlass Cruiser features a split tailgate. The window swings upward, out of the way. That means you can load the Cutlass Cruiser even when you're parked in tight quarters. Swing the bottom section down and you've got a loading platform. Great for furniture, flooring, groceries, gadgets.

Two Economical Ideas.

One for the highway, and one for the city—they're Cutlass Cruiser's EPA mileage estimates: 25 mpg highway, 18 mpg city, 21 combined, with available 260 V8 and standard automatic transmission. Your mileage, of course, depends on how you drive, your car's condition and its equipment. (Power train not available in California.) The Cutlass Cruiser is equipped with GM-built engines produced by various divisions. See your dealer for details.

25	MPG HIGHWAY
18	MPG CITY
21	MPG COMBINED

Four Ride and Drive Ideas.



We know how important it is for a wagon to be maneuverable in city traffic. So we shortened the turning radius... that's the first good idea. Parking and cornering are a pleasure.

To make the ride smooth took two more ideas—a new chassis and new suspension system. Once you feel how well they work together, you might forget you're in a wagon.

You probably won't hear the fourth idea. It's the quiet you'll experience. Quite refreshing.

Three Comforting Ideas.

If a wagon's going to be as comfortable as a Cutlass, it's got to have room. So we increased the legroom and front headroom over last year's model. Next we added hiproom by recessing the armrests under fixed rear side windows. And, of course, the seats are full-foam and very comfortable.

Actually, the list goes on and on. But if you check out the '78 Cutlass Cruiser for yourself, you'll get the idea. A whole wagonfull, in fact.

Discover that great Cutlass Feeling.

Oldsmobile
Cutlass Cruiser
Can we build one for you?

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Come to where the flavor is.
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100's
FILTER CIGARETTES
Marlboro Red or Longhorn 100's—
you get a lot to like.
17 mg "tar," 1.0 mg nicotine av. per cigarette, FTC Report Aug.'77
Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.